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CHRISTMAS LIGHTING.

Never before was the electric light so much in evidence as it was during the past Christmas week, or the ten days immediately preceding the great festival of the year. The shopping districts were flooded with electrical illumination in all the big cities and most of the small ones, and the effects secured were often of a most charming nature, and while profusion was the keynote, we venture to opine that it "paid." There was noticeable also a good deal of special sign lighting, which must have been profitable, even if it did drive up the peak a bit and strain things. Moreover, in spite of the temporary nature of much of the work, we have not heard of a single instance of serious loss or damage due to electricity. Now that the holiday season is over, we trust that central station managers, who are well entitled to a rest, will not take it, but will get after the business that was new or merely temporary and make a very large proportion of it permanent. We expect to see them make 1906 a banner year in the sale of current.

AN ENGINEERING CENTER.

The engineering papers have given their readers recently an illustrated description of the beautiful new United Engineering Building, which is now rising rapidly from the ground, and which if strikes do not hinder will be ready for occupancy in the autumn of 1906. Last week saw also the laying of the corner-stone of the adjacent Engineers' Club, and as that handsome building already has its steel work up to the ninth floor, the hope of occupancy in the early fall seems quite reasonable.

When these two buildings are finished they will represent endowment and investment of not far from $2,500,000, possibly that full amount, in behalf of engineering, at the heart of the city and in a most attractive spot. To-day New York has no professional engineering center, in the sense for example that London has, and we shall be very much surprised if the existence and propinquity of these two buildings, subserving so felicitously the technical and social necessities of engineers, do not create quickly a professional center in which it will be worth the while of engineers and their professional allies to locate in and around West Thirty-ninth Street and Bryant Park. Up to the present moment, engineers and engineering firms have shown somewhat of a preference for the Wall Street district, near the great railway headquarters and the banking houses that are so closely associated with large industrial, engineering and mining enterprises; but travel up and down town nowadays is swift, and the vicinity of the New York Central and Pennsylvania Railroad termini is sure to be very inviting. Certain it is that these splendid homes of engineering activity and club life will act as a great magnet in drawing men together of like professional requirements.

THE METRIC MOVEMENT.

We are glad to see that conservative and influential daily papers like the New York *Herald* and the Boston *Transcript* are lending their weight to the steadily progressing movement in favor of metric weights and measures. It is a good sign of intellectual progress when the exponents of enlightened public opinion take up an important matter like this and push it forward. Our country to-day is growing more cosmopolitan and its interests to-day are world-wide interests. They must not be circumscribed by useless traditions and petty prejudices. At the beginning we borrowed from our English

ancestors a helter-skelter collection of weights and measures and we are using it to-day to our commercial disadvantage. In spite of our decimal coinage we remain hampered by as inconvenient and unpractical a scheme of weights and measures as the world has ever seen. The waste of time in learning it has become a serious matter in these high-pressure days. If it were in itself good and useful one might forgive the sad mischief it makes in elementary education, but on the contrary it is peculiarly objectionable and should be reformed on its own account even if the world at large had nothing better to offer. The world, however, has much the better of us in its use of the metric system, which is simple and convenient and logical. Discussion of the subject has been too much in the hands of scientific men and of manufacturers. It is a matter in which the people should have a keen interest since they and not merely a few isolated classes are the sufferers by our present clumsy scheme. One only needs to look over a school arithmetic to see the source of the child's wasted energy. The time required for learning the strange mixture of illogical units now in use, and for juggling with the common fractions that are entailed by using non-decimal weights and measures, is a real and serious loss that falls heavily upon those whose time for schooling is of necessity short. The time saved in the early years of school life by adopting the metric system could be put to such use as would make better and more intelligent citizens. It is little short of a crime to take so much from the brief school days of the children of the masses that they may wearily acquire the details of a system that has been cast out by science and rejected by the world at large.

THE TESTING OF ELECTRIC GENERATORS AND MOTORS.

In the Digest will be found an abstract of an interesting article from London *Engineering* by Dr. C. V. Drysdale upon the testing of electric generators and motors. The article points out that whereas the Hopkinson method of testing a pair of similar machines, coupled together as motor and generator respectively, is very convenient when large machines are to be tested, yet what is measured in such cases is the joint loss of power, and the proper apportionment of the shares of this loss to the motor and generator respectively becomes a nice question, often easier put than answered. Again, large generators or motors are undoubtedly best tested for efficiency by the method of determining the separate losses of power. In fact, there is no other method available for the large machines in the factory. But in small machines of, say, 5 kw or less, the stray power method is very unsatisfactory. It becomes easy to provide a load for such machines, and it is desirable to measure their mechanical power mechanically. For this purpose it is necessary to observe both the speed of rotation and the torque, received by a generator, or delivered by a motor. There are various ways of measuring a torque transmitted in this manner. One is to connect the two shafts by a spring coupling, and to measure the distension of the spring during rotation. A second is to mount the coupled auxiliary machine in a cradle and so balance it that the torque transmitted can be equilibrated gravitationally. The third is to float either the auxiliary machine, or the tested machine, in a flat boat in such a manner that the torque transmitted disturbs the balance of the boat, as indicated by a spirit level, and calls for gravitational equilibration.

All of these three methods have been used at different times, and with satisfactory results. There is, therefore, nothing novel in any of these three methods, considered broadly. The article here considered, however, describes a number of interesting details in the application of the cradle method. The auxiliary machine is mounted on trunnions containing ball races, and by means of an elevating screw, the weight of the machine is taken off the balls, and floated on knife-edges. The torque transmitted through the coupling is then capable of being equipoised gravitationally, and read off in pounds-feet, gramme-centimetres, or other appropriate unit. The details of the coupling, the bed for the tested machine, and the means for alignment, are very interesting. It is on the perfection of such details that the success of any mechanical method of torque measurement manifestly depends. The boat-and-bath method is perhaps simpler mechanically than the cradle method, and is susceptible of a very high degree of accuracy. Either a flexible spring coupling or a universal joint coupling is necessary, however, in the use of the boat, so as to permit of a slight deviation from true alignment of the shafts when the boat swings horizontally between its stops. Four sizes of boat-and-bath are desirable for the testing of motors from 1/16 kw to, say, 16 kw in power. So sensitive is the balance of the boat method, as indicated by a spirit level, that great care has to be taken with the leads in going on board the boat, lest they introduce unbalanced tensions about the rotating shaft. It is convenient to make the boats square in plan, and flat-bottomed, with only a centimetre or two of free draught or clearance between the bottom of the boat and the bath surface. The curves printed with the article are excellent illustrations of the sensibility of such torque tests. The variations between the losses occurring under a given load when the tested machine is changed from generator to motor or vice-versâ, are very readily followed in such a device.

SPHERICAL CANDLE-POWER PHOTOMETERS.

The *Elektrotechnische Zeitschrift* has recently devoted some attention to a particular form of spherical candle-power photometer described by Dr. I. Bloch, as has been noted in the Digest. There are three different kinds of spherical candle-power photometers. The first employs stationary mirrors at different angles of inclination in a vertical circle about the tested lamp, and so arranged that all the mirrors contribute in adequate proportion to the illumination of a test surface in the photometer. The second rotates a single mirror rapidly in a vertical circle around the tested lamp, and thus gives an average illumination in the photometer proportional to the mean spherical candle-power. The third encloses the source at the center of a globe in such a manner that the light becomes uniformly diffused therein by continual reflections, and a small sample of the light thus diffused is let into the photometer. The first two kinds require that the lamp to be tested should be rotated about a vertical axis. The third kind of spherical candle-power photometer dispenses with any such rotation. It is, therefore, much the simplest structurally, but may run into large dimensions where arc-lamps are concerned.

The importance of spherical candle-power measurements is constantly increasing industrially, because in no other way can lamps be properly compared. It stands to reason that the light-giving power of a lamp can only be correctly assigned on the basis of all the light it emits in every direction, and that any attempt to compare only the light emitted horizontally must be grotesquely in error where the distributions in the vertical differ materially. One might as well rate barrels solely on the basis of their diameters without the least regard to height. A real difficulty with the standardization of incandescent lamps upon a spherical candle-power basis is the apparent reduction of their rating. A 16-cp lamp, as determined from a mean horizontal rating, would only have, say,

twelve or thirteen candles, as determined from a spherical rating. This would depress the commercial value of the lamp in competition with gas, or other illuminants, not rated in the same way. For the present, at least, it seems desirable to retain the mean horizontal rating, but to record in addition the reduction factor to mean spherical candle-power. The reduction factor would be substantially the same for all lamps having the same globe form, and filaments of the same loop form. All comparisons for trade purposes could then remain on the horizontal rating, while all references to luminous efficiency could be referred, as in strict reasoning they must, to the mean spherical candle-power. Until recently a serious difficulty with spherical candle-power ratings was the labor and time involved in the measurement, the time required for a mean spherical determination being manifold that required for the ordinary mean horizontal determination. But now with good spherical candle-power measurers available, or lumenometers as Blondel calls them, this objection is removed, and one rating becomes just as easy as the other.

DIRECT-CURRENT POWER TRANSMISSION.

We take pleasure in publishing this week a paper from Mr. Sprague upon this topic, especially pertinent in view of the present discussion of the Victoria Falls project. While the majority of engineers do not consider constant-current transmission seriously, it cannot be denied that it has made sufficient headway upon the continent to at least entitle it to a fair hearing. Mr. Sprague attacks the subject from the standpoint of practicable cost of the combination of plan and line for given efficiency, thence obtaining the variation in cost of power delivered with varying loss in the line. As in every case of such computations, certain assumptions have to be made, of which some are usually unjustifiable. In constant-current working one is no more likely to do this than elsewhere, and one condition usually neglected is here of no consequence. Ordinary calculations for minimum cost of power delivered do not include any condition of maximum voltage loss for the necessary regulation, an omission which is commercially serious. At constant current the line loss is stable, so that regulation need not be considered as affected by it. On the other hand, Mr. Sprague neglects the relation of line voltage to the practicable sizes and outputs of the units employed in distribution, which is one of the serious questions regarding the method. His equations deal with transmitting and receiving units unconditioned by size and voltage, so that while the results are most interesting they are very difficult to apply to a concrete case unless well within present experimental limits. Hence one must be cautious in applying his formulas save to the simple transmission here assumed as a type of the system. Another weak point in the discussion, here as elsewhere, is the treatment of K, here the cost of plant per hp, as a constant with respect to the voltage of the system. Even assuming that for each machine the voltage is as high as the state of the art permits, high voltage on the line means extreme sub-division of the capacity with the added cost which that implies.

Passing over these matters, however, as secondary to the main facts of the case, Mr. Sprague's figures give an excellent synopsis of the situation as regards the economic side of direct-current transmission, and lead, as might be expected, to the same broad relations of voltage, distance and amount of power found in the general discussion of power transmission. In applying his equations to the Victoria Falls project, for instance, Mr. Sprague finds that conditions of economy require at any reasonable value of the efficiency about the same voltages assumed in considering the matter from the alternating-current standpoint as these have been from time to time determined. The fact is that no amount of dodging will keep Ohm's law from extracting its due tribute of copper, and whether one works at constant current or at constant potential, one has to face the inevitable energy loss in the conductor. To make any headway in very long distance transmission by whatever system, the voltage must be pushed up as far as possible, and the main theoretical advantage of constant potential as against constant current working is that in the former case the voltage is at its maximum value all the time irrespective of the load. And this advantage carries with it the difficulty of imposing at all times the maximum insulation strain upon the system. At equal maximum voltage for a given amount of energy transmitted, the full load current on the line will be the same whether one works at constant current or constant potential, but at constant current the energy loss is constant at all loads, while at constant potential the insulation strain is constant. The relative importance of these two conditions as one nears the working limit of voltage remains to be determined. We wish that Mr. Sprague had gone further and taken up this phase of the situation.

Of course, this practically means a comparison between direct constant-current and alternating constant-potential working. The latter undeniably labors under the disadvantage of a greater maximum voltage for the same working voltage, while the former suffers from the necessity of operating many machines in series for both ends of the main transmission. As the magnitude of the project increases and the necessary working voltage rises, one enters a region of new conditions. The alternating-current side of the problem is fairly simple aside from the line insulation, for one can certainly build transformers of large output for a working voltage of even the 200,000 volts or so that seems necessary for a transmission like that from Victoria Falls to the Rand. But for a direct constant-current transmission the situation is not so clear. Even at 5,000 volts per machine, which is far higher than anything yet reached for generators for the current required, forty generators would be needed to secure the necessary total pressure. With 200 amperes per machine one would be using 1,000-kw generators in a case where with alternating-current units one would be dealing with 8,000 or 10,000 kw per machine. This is a pretty serious difference, and the real question hinges on the maximum line voltage that can be insulated. If the alternating current were limited to the same maximum voltage as the direct current, the cost of the line assuming a maximum of 200,000 volts would be so largely in favor of direct current as to put it decidedly into the game. The whole matter of such work resolves itself into a question of possible line insulation, and as we have before intimated in these columns, it would be the part of wisdom for the projectors of the Victoria Falls scheme to make a reconnoissance on a very large scale before entering upon their campaign. It is no joke to undertake work at 150,000 or 200,000 volts when the maximum now in use is a scant 60,000, and with too low a factor of safety on the insulators at that. And as Mr. Sprague's figures plainly indicate, constant-current working cannot be turned down offhand, whatever may be one's preconceived notions as to its fitness. Our own tendency is to believe that alternating-current working at the required voltage can be successfully carried out, but we think Mr. Sprague's careful consideration of the other side of the question is very timely and will do good by setting engineers to thinking. Certainly a scheme of working which has done commercial work at voltage comparable with the highest alternating-current voltages in use cannot be put aside without thorough investigation, which we earnestly hope it will get.

Society of Illuminating Engineering.

One of the notable developments of the past few years has been the rapid growth of interest in the subject of efficient artificial illumination as related to the selection of lighting units for different service, modification of the natural distribution of light therefrom by the use of globes and reflectors, the disposition of the lights for the best effect, both utilitarian and æsthetic, and the production of a given illumination with the highest economy. The knowledge necessary to a consideration of all the various details entering into the design of the more complicated illuminating layout is to a very considerable extent of a technical nature, which justifies the use of the term "engineering," and already the term "illuminating engineer" has come to be recognized as a proper designation for those who specialize in the art of illumination.

The strength of this movement is shown in the steps taken in New York last week toward the formation of a society to advance the practical art of illumination and to bring about co-operation between the illuminating engineer, the gas engineer, the electrical engineer, the architect and the designer of electric and gas fixtures. A meeting called for this purpose on December 21 was attended by representatives of the several interests above noted, and after discussion the opinion was unanimous that the formation of such a society was justified. Several names were suggested for the body and this finally, together with the drafting of a constitution and by-laws, fixing of annual dues, etc., were left to a committee which was instructed to report at an adjourned meeting to be held early in January, when the society will be formally organized.

Among the objects of the society, in addition to those above noted, will be to promote the arts and sciences connected with illumination and illuminating engineering; to hold meetings for the reading and discussion of suitable papers and to publish and distribute such papers, discussions and communications as may seem fit; to gather authoritative data on lamps, lighting and illumination; to bring about the standardization of methods of measuring light and illumination and of rating lamps, and the general acceptance of such nomenclature with reference to illumination as may be adopted by the society; and to co-operate with other institutions such as the American Institute of Electrical Engineers in work common to both.

The meeting was called in a circular signed by Messrs. L. B. Marks, E. L. Elliot and V. R. Lansingh. Among those in attendance were, in addition to these gentlemen, Messrs. Waldo S. Kellogg, architect with Carrere & Hastings; W. D'A. Ryan, illuminating engineer General Electric Company; A. D. Page and F. W. Wilcox, Edison Lamp Works; Major E. L. Zalinski, illuminating engineer; Dr. C. H. Sharp, Wilson S. Howell and Preston S. Miller, Electrical Testing Laboratories; Charles A. Barton, Nernst Lamp Company; J. S. Codman, illuminating engineer, Boston; O. A. Nygatt, V. R. Lansingh, H. M. Lauritzen and A. A. Ernst, Holophane Glass Company; Arthur Williams, A. A. Pope, Walter R. Boyd, E. A. Norman, Charles K. Nichols and John Lloyd Price, New York Edison Company; F. N. Olcott, with Black & Boyd, gas and electric light fixtures.

Consolidation of New York Traction Interests.

The long-expected has occurred at last. Mr. August Belmont has purchased all the bonds and stock of the Metropolitan Street Railway and Metropolitan Securities Co., held by Thomas F. Ryan. This carries control of the Metropolitan companies and gives the Belmont interests complete control of the transportation systems of Manhattan and the Bronx.

The combined capital stock of the New York street railways now controlled by August Belmont is $206,000,000. The New York City Railway Company, including the Metropolitan and the Bronx lines, has a total capitalization of $101,000,000. The Manhattan Elevated has a capital of $55,000,000; the Interborough Rapid Transit Company a capital of $35,000,000, and the Queens County trolley system a capital of $15,000,000.

The plan of consolidation, in a $222,000,000 holding company, is announced this week as follows: "Mr. Belmont and Mr. Ryan, after consultation with their respective associates, have approved a plan for the union of the Interborough and Metropolitan interests, which will be formally submitted to the stockholders of the corporations involved as soon as the lawyers have completed the necessary papers. The plan contemplates the organization of a new company which shall issue its securities in acquiring the shares of the Interborough, Metropolitan Street Railway, and Metropolitan Securities Companies, upon the following terms:

For every share of Interborough stock:	
New collateral trust 4½% bonds, secured by the deposit of Interborough stock	200
New common stock	90
For every share of Metropolitan Street Railway stock:	
New 5% cumulative preferred stock	100
New common stock	50
For every share of Metropolitan Securities stock (with $75 per share paid).	
New common stock	85

"It is confidently believed that the proposed arrangement will not only be beneficial to the stockholders of the corporations involved, but that it will be advantageous to the city and to the public. It is admitted in this connection that the transportation facilities in this city are already superior in rapidity, comfort, character of equipment and low cost of travel for long distance to those of any other city in the world. Yet they should be further greatly improved by reason of the greater opportunity now offered to co-operate harmoniously with the city in providing for important extensions and additions to the facilities of travel within the Boroughs of Manhattan and the Bronx."

Electrification of the Atlantic City-Philadelphia Line.

Note has already been made in these pages of the decision of the Pennsylvania Railroad to equip electrically that part of its system lying between Atlantic City and Philadelphia. We are now glad to be able to give details as to this interesting important enterprise. That portion of the Pennsylvania Railroad to be electrified, comprises some sixty-four miles of steam road lying between Camden and Atlantic City, New Jersey, being a portion of the West Jersey and Seashore branch of the Pennsylvania system. It is proposed to utilize the Cape May line of this system from Camden as far as Newfield, this line being double tracked with 100-lb. rails, and to build an additional track from Newfield to Atlantic City, making the lines double track throughout. Over this roadbed an express service will be established. The initial installation will provide for a three-car train every fifteen minutes between Camden and Atlantic City, making the sixty-four miles in eighty minutes without stops. The maximum speed of the cars will be between 55 and 60 miles per hour.

In addition to this through service to Atlantic City, a half-hourly schedule is planned, consisting of two-car trains between Camden and Millville, 40 miles, and ten minute service of single cars between Camden and Woodbury, 8½ miles. Full service will call for 58 cars in operation, each equipped with 200-hp, direct-current motors. These motors will be similar to those now being manufactured by the General Electric Company for the equipments of the New York terminal of the New York Central & Hudson River Railroad. The motors will be controlled by the Sprague-General Electric automatic multiple unit system.

Current will be furnished to the cars by the third rail system, except on the sections between Camden and Woodbury, and Newfield and Millville, where the cars will obtain the necessary current by an overhead trolley. The speed on these sections is less than on the main line. At Camden, the power house will be located. Power for the operation of the cars will be furnished by three 2,000-kw General Electric Curtis turbo-generators of the three-phase alternating current type, having a frequency of 25 cycles. From this power house transmission lines will be run to six sub-stations between Camden and Atlantic City, and a seventh sub-station at Millville to supply that section of the road lying between Millville and Newfield.

The transmitting potential will be 33,000 volts. At the sub-stations a total capacity of 11,000 kw in rotary converters will be provided, delivering direct current to the third rail at 650 volts. The individual units will be of the standard General Electric type and will have a capacity of 750 kw. They will be started from the alternating current and by means of taps on the stepdown transformers. The contract with the General Electric Company calls for the completion of this road by July 1, 1906, in order to take care of the heavy summer traffic. The total amount of money involved is about $3,000,000.

The Electrical Equipment for the New York Central.

Subjoined will be found an extremely interesting correspondence which is in a sense self-explanatory, and the origin of which, our readers will see at once, refers back to letters and articles already appearing in these pages with reference to the question of direct versus single-phase alternating-current apparatus upon the New York Central terminals. In the case of the New York Central Railroad direct-current apparatus built by the General Electric Company has been adopted; more lately single-phase apparatus built by the Westinghouse Electric & Manufacturing Company has been adopted by the New York, New Haven & Hartford Railroad, to operate over the same section, south of Woodlawn and into the vast new double-decked terminal depot at Forty-second Street. Mr. Frank J. Sprague, member of the New York Central Electrical Commission, but in his individual capacity, gave out a criticism or discussion of the subject, arguing against the feasibility and propriety of using the two electrical methods together, under the difficulties involved. To this some of the officials of the other road replied publicly, but the Westinghouse officials made no public rejoinder. There was issued, however, in private circulation a correspondence between President W. H. Newman, of the New York Central, and Mr. George Westinghouse, which until the close of last week was unavailable for general publication, at the request of both parties. It has now been "released," and with it we are able to give a further letter of Mr. Westinghouse to one of our steam railroad contemporaries, somewhat enlarging the area of controversy and introducing one or two new considerations. The correspondence follows:

October 27, 1905.

W. H. NEWMAN, ESQ., President New York Central & Hudson River Railroad Company, Grand Central Station, New York.

DEAR SIR:—There can be no more important questions before you and your officers than those involved in the present electrification plans for your New York terminal and adjacent suburban lines. When your company, under public pressure and legislative enactment, undertook the change in your terminal facilities involving the use of electric power for your cars and trains, there had been not so much development of the single-phase system now actively under discussion as could warrant its adoption, and therefore the selection of the continuous-current system by your commission of engineers was an obvious outcome of the situation as it then existed, notwithstanding there had been enough progress made with alternating-current single-phase traction to warrant frequent references in my conferences with you and your officials to the possibility of that system being perfected in time for a change in your plans.

The business relations existing between your company and those I represent, and the consideration you and your officials have always given my personal views on the subject of the electrification of your railway, seem to demand the prompt fulfilment of my recent promise to set out to you in a letter the reasons why, because of the possible much greater use of electricity upon many of your lines of railway, your company could and should now change your plans providing for the use of the continuous-current, third-rail equipment, to those employing the alternating-current single-phase overhead system.

These are some of the controlling facts as they have been developed:

1. Motors can be as successfully and economically operated by single-phase alternating currents as by continuous current, with the advantage in favor of the use of the alternating current, in that the great variations in speed requirements of a railway can be more easily and economically met thereby than by continuous current.

2. Single-phase electric locomotives larger than you require have already been constructed and operated by current from overhead lines.

3. Electro-pneumatic multiple-unit control has been perfected whereby trains fitted with alternating-current motors can be better operated than those propelled by continuous current.

4. Both locomotive and car equipments with multiple-unit control have been evolved, whereby either the alternating or direct-current systems of distribution can be used.

5. If there is any desire for the use of the storage-battery system, such batteries can, with rotary transformers, be as well utilized in connections with the single-phase system as with the direct-current system.

COMPARATIVE COST.

Bearing upon these great questions are the comparative costs of the line equipment of the two systems.

As an example, the comparative cost of line and sub-station installation for alternating-current single-phase and direct current to meet the conditions of traffic now existing on the section of the New York, New Haven & Hartford Railway from Woodlawn to Stamford, based on the following:

(a) Single-phase alternating current, high-tension transmission transformer sub-stations, 6,000-volt overhead line supported by catenary construction from bridges spanning four tracks.

(b) Direct current employing high-tension alternating-current transmission, rotary converter sub-stations and third rail at 600 volts.

COMPARATIVE COST PER MILE OF FOUR-TRACK LINE.

	Single-phase Alternating system.	Direct-current system.
Sub-stations	$1,714	$16,150
Contact line	12,436	18,872
Transmission line	1,815	2,181
Track bonding	308	308
	$16,273	$37,511

Difference per mile in favor of alternating-current, single-phase, $21,238.

COMPARATIVE COST PER MILE OF DOUBLE-TRACK LINE.

	Single-phase Alternating system.	Direct-current system.
Sub-stations	$1,542	$13,840
Contact line	6,750	9,436
Transmission line	1,815	2,181
Track bonding	154	154
	$10,261	$25,611

Difference per mile in favor of alternating-current single-phase, $15,350.

These figures mean, assuming that your company may in the near future electrify its main lines from New York to Buffalo, that the extra cost of the line equipment with the continuous-current system for 450 miles of four-track road of the New York Central main line would amount to $9,000,000, and for the double-track of the West Shore road, $6,750,000. From these figures you can easily compute what the additional cost would be upon the entire mileage of the New York Central's other lines east of Buffalo and those west of that point.

This great difference in the first cost of the continuous-current system, with the almost absolute certainty that traffic depending upon the third rail will be subject to many interruptions during your severe winter months, coupled with the constant danger from live third rails upon the surface, would seem to make most fortunate the advent at this moment of the complete system of overhead single-phase apparatus, before any great quantity of car and locomotive apparatus has been constructed on your order, or the line and overhead construction has been begun under your extensive plans.

Stated briefly, your situation seems to be this: Your power house and its equipment now under construction is suitable, without substantial change, as are also your sub-station rotaries and storage batteries, for the operation of single-phase equipment. Orders have been placed for 35 electric locomotives, costing, say, $900,000, and 180 electric car equipments with multiple-unit control, involving an additional $775,000. Neither the locomotives nor the cars and equipments will be needed before September of next year, according to your present desires, but most probably not before April in the year following, because of the inevitable delays in the carrying out of so important a work as you now have in hand.

Had the order for the locomotives and equipment been placed with the Westinghouse Electric & Manufacturing Company, that company would have been very glad to have taken up with you a change in programme on a reasonable business basis, and I assume that your contract relations with the General Electric Company are of such a character that you can also ask them to discuss the change in the character of equipment or arrange with them for a specific sum to cover the amount they have already expended, with such profit as they are likely to make from the completion of the work. Such sum ought to be an unimportant item as compared with the costs which may result from the completion of the work along the lines of your present plans. We are aware that the General

Electric Company have admitted their inability to produce locomotives of the character which the Westinghouse Company has contracted to supply the New York & New Haven Railway, but such admission on their part does not really affect the question of the Westinghouse Company's ability to produce such apparatus in the necessary quantity and in the time required.

You know of the diametrically opposed views and interests of the Westinghouse and General companies and of the strife between them. You also know of my full recognition that the works of the former company being upon your line at Schenectady, it is natural that your company should give the General Electric Company at least a preference in the placing of contracts for electrical machinery.

The greatest difficulty in arriving at a conclusion is likely to be due to the commercial rivalry between the two electric companies, but there seems to be no good reason why your company should be a victim of such commercial strife. I feel confident that my recommendation that you now take steps to effect the change from your present plans will be found to be based upon the best of reasons, and that that recommendation will in all probability prevail if the matter is most carefully investigated, as I am sure it will be.

I am sending Mr. Wilgus a letter with some technical correspondence, of which I have the pleasure in enclosing you herewith a copy, with a hope that you may find time to read the same.

Inasmuch as many of your directors know only the one side of this important situation, am I asking too much of you to have my letter placed before them? I ask this because of my very great desire to have my suggestion that your company now make a change fully understood and appreciated by your associates. Believe me,

Very truly yours,

GEO. WESTINGHOUSE.

The letter inclosed by Mr. Westinghouse follows:

October 27, 1905.

Mr. E. M. Herr, First Vice-President:
Westinghouse Electric & Manufacturing Company,
Pittsburg, Pa.

I have noted H. H. Westinghouse's letter addressed to you, in which he gave the result of a conversation with Mr. Wilgus, of the New York Central, in which Mr. Wilgus brought forth certain reasons, which, in his opinion, militated against the use of single-phase apparatus in the New York Central terminal.

It would appear, from the statements advanced by Mr. Wilgus, that he had drawn his conclusions on incomplete or unrealiable information, as we have not yet given out sufficient data to anyone except our customer that would enable comparisons of this nature to be drawn which would be of any value.

While the comments in Mr. Westinghouse's letter are under certain more or less definite heads, for the purpose of clearer discussion, I will set forth my views under somewhat more general headings:

LOCOMOTIVES.

As to Production.—It has been assumed in the communication referred to that owing to the apparent novelty of the design of the New Haven locomotives, insufficient time is available to produce a successful single-phase locomotive in order that it may be ready for the date set for the proposed operation by electricity of the New York Central terminals. Our opinion on this matter is that this single-phase locomotive operated as a direct-current equipment comes much nearer to standard, well-accepted direct-current practice than the locomotive adopted by the New York Central for its service.

The type of mechanical construction, using swivel trucks, is very similar to that universally used on heavy electric traction cars, while the method of control, involving series parallel operation of the motors, is common practice everywhere.

The type of motor used is not a radical departure from direct-current practice except in minor features of construction. The motors are extremely well protected from dirt and moisture, and they possess certain features which make them superior to any large direct-current motors yet built by any concern, more especially as regards entire freedom from "flashing," "bucking," and difficulties of commutation, not to speak of the great advance which has been made in the application of forced ventilation.

If the Westinghouse Company had been asked to build passenger coaches fitted with four motors of the capacity used on this locomotive, these motors to be operated with the usual electro-pneumatic series parallel-control system, there would have been no hesitancy in undertaking the contract, and it would not have been considered necessary to have made a long test on a trial equipment. The problem would have been considered as merely a further development of the type of equipments now operated on the Pennsylvania, New York & Long Island Railroad.

On the other hand, the long time taken by the New York Central Railroad for testing and experimenting was but a natural precaution, in view of the many radical departures from standard practice which were incorporated in their locomotive. For instance, the type of motor used on the New York Central locomotive is entirely open, and exposed to dirt and weather conditions. This construction is a radical and questionable departure from what experience in railway work has taught us is good practice, and it would have been folly to have attempted to put such machines in operation without very long and extended tests. Aside from the mechanical features of this equipment, the motors electrically and magnetically are such as had never been tried out by the experience gained by long service.

The result of all previous experience in electric traction has apparently been abandoned in the New York Central type, and I consider that that locomotive is an infinitely greater experiment than any that the Westinghouse Company could be considered as offering in the New Haven type.

In the course of our consideration of this problem, nothing has developed which leads us to have any doubt as to our entire ability to meet the requirements of delivery with an entirely successful locomotive.

As to Operation.—It is interesting to note that these locomotives have been pretty generally referred to as "single-phase" or "alternating." We, among ourselves, have used these terms, and perhaps are responsible for the nomenclature. In reality, however, the equipment of these locomotives is simply a high-class direct-current arrangement adapted for operation on alternating-current as well.

The motors are not primarily designed for alternating current and adapted for operation on direct current, but knowing the problem which we had to meet, they were in reality designed for the very highest class of direct-current service, and they will operate successfully on alternating current. In accomplishing this result, the fundamental features which make for a good direct-current railway motor have not been slighted, but on the contrary they have been amplified in order that the motors may work successfully on alternating current. We may take it as a fundamental condition in this class of work that in order that a motor work successfully on alternating current it must be an extremely good direct-current motor.

Method of Control.—It has apparently been assumed, although this example of many of our single-phase roads is to the contrary, that a multiple-unit system of control is not possible or feasible with the types of equipment which we are building for the New Haven road. This is, of course, an error, but it is probably brought about by the fact that only the electric system of multiple-unit control has been kept in mind, whereas the system which we use is the electro-pneumatic. It has further been assumed that with any system of control duplicate apparatus is necessary for direct-current alternating-current operation, which, of course, is another misconception, as the type of control which we are building for the new locomotives, and which is also in use on other of our installations, involves the employment of the same controller for both alternating-current and direct-current service.

This assumption has also called forth criticisms of the complications and difficulties in passing from direct current to alternating current, or the reverse, and much stress has been laid upon the awkwardness of having to employ two systems of control. As a matter of fact, roads now using this system pass from one current to the other at speeds as high as 50 m.p.h. without the slightest delay or any indication to the passengers that such a change has been effected. The whole mechanism to accomplish this is of the utmost simplicity and reliability.

It should be borne in mind that when multiple-unit control is referred to, we do not mean that form which depends for its operation upon the use of the line current, but upon the form used successfully and exclusively by our company, namely, the electro-

pneumatic system, which depends for its operation upon the use of compressed air.

The type first mentioned, that is, the straight electric control, is obviously but ill-suited to use on alternating-current direct-current systems without additional prohibitive complications.

If the New Haven road should decide that it wishes to operate its suburban or any other service by multiple-unit trains, there is no reason why we cannot furnish entirely suitable equipments for direct-current alternating-current operation.

POWER CONSUMPTION.

Locomotives.—In Mr. Westinghouse's letter it is stated that the single-phase locomotive, when on direct current and running at low speed, requires double the amount of energy compared with a locomotive designed for direct current only. This statement, when read by itself and without any other consideration of the conditions, is apt to lead to very erroneous conclusions. The statement is true only when the direct-current alternating-current locomotive which we have sold to the New Haven road is compared to the case of a direct-current locomotive equipped with four direct-current motors, where all four can be thrown in series on the low speeds. Where the ordinary series-parallel control is used, such as on the Interborough system and the New York & Long Island road, and which also is proposed for the New York Central multiple-unit cars, there will be no essential difference in current consumption between the direct-current alternating-current and the straight direct-current, provided the equipments are designed for the same normal car speed.

In criticising the apparent disadvantage in economy of the direct-current alternating-current locomotive at low speeds, it would be only fair at the same time to show its superiority on higher speeds, which, as I will point out later, more than offsets this apparent disadvantage in power under which it operates at the very low speeds.

It is true that the direct-current alternating-current locomotive equipped with four motors, will, at certain very low speeds, consume what appears to be a large percentage excess of current over the straight direct-current locomotive equipped with four motors, but it should be remembered that this condition of lowest speed also means the point of least power consumption. This being kept in mind, it can readily be seen that a large percentage increase of current actually means only a small increase in power requirements.

At higher speeds the conditions, when comparing the two types of locomotives, is exactly reversed, the locomotives which we are building being of greater economy at the various higher speeds than those with which they have been compared to their disadvantage.

At one-fourth speed the total power consumption of the direct-current alternating-current, or the straight direct-current locomotive, is in no sense a controlling feature. It is the power required to accelerate the locomotive up to its full speed that is of importance, and also the power consumption when running at high speeds.

The New Haven service up to Woodlawn may be considered as consisting of three sections: First, a short section where the speed may possibly be 6 m.p.h.; a second section where the speed may possibly be 26 m.p.h., and a third section, where the speed may possibly be 45 m.p.h. The total energy consumption of a train on the first section, whether with direct-current alternating-current or straight direct-current equipments, will be small, due to the shortness of this section of the tracks, and to the fact that the input of the motor at these lower speeds is a minimum.

On the second section the direct-current, alternating-current will be very nearly at a par.

On the third section, where a high-speed service is required, the direct-current alternating-current locomotive, as designed for the New Haven road, will present considerable economies over the straight direct current as adopted by the New York Central.

It should be remembered that the higher economy gained with the utilization of larger amounts of power will offset a very large per cent loss in economy at the low speed when very small amounts of power are required.

The results of a comparison of a typical run on the New Haven service, showing in the first case the direct-current alternating-current locomotive which we propose to furnish, and in the second case, a straight direct-current four-motor locomotive adapted to handle the same train service, are shown in the table below:

NEW HAVEN LOCOMOTIVE.			
Speed M.P.H.	Time, seconds.	Kw.	Distance, feet.
0 to 6	13	654	59
6	58	150	570
6 to 21.5	36	654	....
21.5 to 25	12	654–420	1715
25	52	240	3632
25	Momentary	720	3632
25 to 45	240	720–324	17470
45	88	303	....
45 to 25	14	0	23749
25	25	240	24649
25	Momentary	720	....
25 to 32	28	720–486	....
32 to 25	5	0	25906
25	23	240	26761
25	Momentary	720	26761
22 to 46.6	404	720–312	....
46.6 to 0	262	0	62357
30 Watt-hours per ton mile.			

FOUR-MOTOR, DIRECT-CURRENT LOCOMOTIVE EQUIVALENT TO NEW HAVEN.			
Speed M.P.H.	Time, seconds.	Kw.	Distance, feet.
0 to 6	13	327	59
6	58	75	570
6 to 9.5 / 9.5. to 21.5	29	654	....
21.5 to 25	12	654–420	1517
25	52	240	3632
25	Momentary	420	3632
25 to 36	209	420–210	....
36	182	210	....
36 to 25	8	0	23749
25	25	240	24649
25	Momentary	420	24649
25 to 29	28	420–304	....
29 to 25	4	0	25906
25	23	240	26761
25 to 44.8	45	1392	....
44.8 to 61.4	183	1392–570	....
61.4 to 0	382	0	62357
30.1 Watt-hours per ton mile.			

From which it appears that the actual energy per ton mile required by the direct-current alternating-current locomotive is almost identical with that required by a straight direct-current locomotive under the same conditions of service.

Effect on Power House and Sub-Stations.—If reference is made to the foregoing table, which shows the relative power requirements of the two types of locomotives at various speeds, it will be seen that as regards the fluctuation in the power supplied the direct-current alternating-current will represent an easier condition than the straight direct-current locomotive, as the load will be very uniform. While the minimum load will be greater than the straight direct-current, the maximum or peaks will represent less power. Such a condition is in reality more ideal and much easier on the power house or sub-station than one where the same total power represents greater maximum and minimum values. The ideal condition as regards efficiency at generating and sub-stations would be a constant power or a constant load, and we come nearer to this condition with our direct-current alternating-current locomotive than is obtained by the New York Central type, on the basis of the same total power consumption in each case.

In conclusion, I believe that the statements made herein are a sufficient refutation of the views set forth in Mr. Westinghouse's letter. The New Haven road, however, in adopting apparatus adapted for single-phase operation, is looking further than the limitations imposed by the terminal requirements. The engineers of the New Haven road recognize that the extension of electric operation was absolutely prohibited, both for physical reasons and reasons of economy, if direct current were adhered to.

The necessities of economical high-speed railway service require that power shall be drawn by the system in proportion to the work it has to do. The trains must at times run at full speed, at intermediate speed, and in emergencies at extremely high speeds, to make up for loss of time. The single-phase alternating-current locomotive or equipments are the only feasible type which draw power in exact proportion to the work to be done. Direct-current equipments have but two or three points of maximum economy. They have no ability to go beyond a certain maximum speed, which is a frequent requirement of railway service. At all other speeds, except these few economical points, power is wasted in regulating the speed. The single-phase alternating-current equipments utilize power at all speeds at maximum economy. I believe that this feature alone is sufficient justification, aside from the many other advantages of the system, for its adoption by the New Haven Railroad.

B. G. LAMME,
Chief Engineer Westinghouse Electric & Manufacturing Company.

As bearing on this general subject, Mr. Westinghouse also contributes the following letter to the current issue of the *Railroad Gazette:*

THE SINGLE-PHASE ALTERNATING AND THE DIRECT-CURRENT SYSTEM.

111 Broadway, New York, Dec. 19, 1905.

To the Editor of the *Railroad Gazette:*

The railroad officials of the country are so deeply concerned in all that relates to the electrification of their lines that I deem it important now to take notice of an article which appeared in your issue of October 20, as well as of the article in the *Street Railway Journal* of October 21, written by Frank J. Sprague, one of the important engineers upon the Electrical Commission of the New York Central, which thereby precipitated a far-reaching controversy as to the relative advantages and disadvantages of the two systems of electric traction, namely, the alternating single-phase,

which can be operated with overhead conductors, and the direct-current system, which, for railroad purposes, requires a third rail.

In dealing with this subject, it is well to recall that when the alternating-current system was first introduced into this country by the Westinghouse Company in 1886, the advocates of the direct-current system, feeling that their particular business and their efforts to secure a monopoly of the electric light and power industry of the country might, as they really have, become abortive, left no stone unturned to accomplish the suppression of this new and comprehensive electric system. Legislatures in several States were invoked to pass laws to prohibit any use whatever of the alternating electric system, and the present method of killing criminals in New York State was the direct outcome of the organized efforts of the business rivals of the Westinghouse Company, who were also enemies of the public, to use that company's make of alternating-current generators for this base purpose in the hope that their legislative efforts referred to might be crowned with success.

The triumphant success of the alternating-current system, without which none of our great railroads could have had the benefit of electric traction, needs no words of mine to emphasize it; but there are arrayed to-day against the alternating-current single-phase system of electric traction many of the same men and the same interests, actuated by the same commercial spirit and using the same methods and tactics as were employed by them in the days referred to when they began their "peculiar" opposition to the alternating electric system.

Public discussion and the facts already demonstrated will bring discomfiture to that organization which has made a long and losing fight to acquire a monopoly of the electric light and power business of the country, and will insure the acceptance in this country of the single-phase system as the only solution of the electric traction problem on main railroads, as has already been the general result of a most intelligent consideration of the subject in Europe.

In 1886 it was said by some influential people that I was making a mistake in attaching so much importance to the efforts being made at that time to discredit the alternating system. The beneficial results which have followed my efforts in that and other cases, in the true interests of users of electric apparatus, impel me to believe that I would be remiss at this moment to accede to like suggestions which have been recently made to me.

Mr. Sprague, while disclaiming that he was speaking officially for the New York Central Company, seems to have left no doubt in the minds of a large number of people that his views were those of the members of the New York Central Electrical Commission. In his haste to create for his clients a strong public opinion calculated to induce the officials of the New York & New Haven Railroad to give up their plan to use the single-phase alternating system and to take exactly the same kind of apparatus as the New York Central had already contracted for, namely, the third-rail direct-current system, and in pleading the great need for uniformity, Mr. Sprague forgot to inform the public, probably as he would have done had he had more time, that he is receiving a very large retainer under a contract of years' duration, whereby, though he may become consulting engineer for a railroad, yet he cannot do so if, in the opinion of the officials of the General Electric Company, such work or obligation may be in conflict with the interests of that company; and having a particular personal interest in his own form of control, which is suitable for direct currents only, he equally overlooked the fact that the electro-pneumatic multiple-unit control made by the Westinghouse Company had been fully perfected for the operation of locomotives and multiple-unit trains when operated by the alternating single-phase or the direct current.

Your article above referred to also tended to mislead its readers upon most important railroad questions, because it seems to have been written with a knowledge of only one side of a situation, and thus under an impression that the action of the New York, New Haven & Hartford road might prove not helpful, as it will, but rather disadvantageous to electric traction in general.

Believing that a great effort had been inaugurated to fasten upon the railroads the direct-current third-rail system as a standard, through a specious appeal in this particular case for uniformity, and knowing that nothing more harmful could happen to railroad interests than to extend that system, I wrote a leter, after a conference on the subject, to President Newman, of the New York Central, and inclosed therein a letter from Mr. B. F. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, in criticism of observations made respecting the action of the New York, New Haven & Hartford Railroad. Copies of these letters are inclosed herewith for your perusal and publication.

An intelligent public discussion of these important questions cannot fail to be of the utmost benefit, and in saying this I have in mind the rather harsh criticisms made of my letter published in the *Railroad Gazette* of January 17, 1902, written in a spirit of friendliness and helpfulness to the New York Central officials, who were in my opinion, being misjudged with reference to the accident which had shortly before occurred in the New York Central tunnel. The result of that discussion has, as all know, been the development of the steel car, so that there are now a number of firms ready to supply non-combustible cars, which are superior to the old form; in fact, the Interborough, the Pennsylvania, and the New York Central have all ordered steel cars in large numbers, and no one would now think of doing otherwise.

In conclusion, I wish to say that the single-phase alternating-current system not only equals the direct-current system in every particular, as fully set out in Mr. Lamme's letter, but in several respects has advantages of supreme importance, two of which I will particularly refer to.

No problem is of higher importance than that relating to the avoidance of the destruction by electrolytic action of all underground metallic work, such as employed in the great improvements of the New York Central, the Interborough and other underground work yet to be undertaken, and the water and gas pipes of New York. These works have been created, not to last a decade, but are intended to, and should, endure for ages. It has been shown fully and completely that the direct current is working all of the time in the destruction of some of the metallic structures, especially water and gas pipes, adjacent to electric conductors, which metallic structures invariably act as conductors for some of the current escaping from the uninsulated rails forming part of the electric circuit in railroad operations.

In illustration of this electrolytic action of continuous currents, I enclose a photograph with memorandum of explanation showing the electrolytic action due to the leakage of electric current from a street railway line in East Pittsburg. I do not pretend that the rapidity of action in his case is likely to occur, except under extraordinary conditions. However, had the alternating current been used, there would have been no electrolytic effect whatever. This electrolytic difficulty is a well known one. It cannot be hid or covered up and must be surmounted, because the sum involved in this phase of the electric problem is so great as to justify every possible effort to avoid its rapid depreciation or loss.

In the matter of the regulation of the speed of trains upon standard railroads, the single-phase system will have it all its own way, because with the continuous current no speed can be attained greatly in excess of the predetermined one. In railroad practice it often happens that speeds of 70 m.p.h. and 80 m.p.h. are necessary to make up for time lost. If the direct-current motors are constructed for this speed, then at the ordinary speeds of 40 miles, or 50 miles, there would have to be introduced a dead resistance in the motor circuits to reduce the voltage, which condition can be maintained only for a short time, and is in effect not unlike applying a brake to hold the speed down. The only other way to maintain an average low speed would be to put the current on and off, an intolerable and uncomfortable practice one frequently observes when a motorman is obliged to move a street car at a slow speed. In the single-phase system, the auto-converters used in connection with the locomotive and car equipments provide for continuous running at any desired speed in a manner equivalent to the placing of the throttle and reverse lever in appropriate positions.

My reference to Mr. Sprague and his article and his interests are reluctantly made, and are not to do him an injustice, but to prevent an injustice being done to vast interests by the forgetfulness referred to.

GEO. WESTINGHOUSE.

The electrolytic action referred to in the preceding communication of Mr. Westinghouse occurred in one of the natural gas wells on the property of the Westinghouse Electric & Manufacturing Company in East Pittsburg. The action was found to be due to

electrolysis, caused by stray currents from the street railway system. This gas well was in operation for several years with 2-in. tubing, consisting of bare steel pipe with no preservative or other protection. The well suddenly gave out, and upon pulling the tubing it was found that for 30 ft. or 40 ft. above the rubber packing (located about 1,800 ft. down for preventing access of water to the gas-bearing strata), the pipe was greatly reduced in thickness, more or less uniformly but broken entirely through in several places, thus causing the well to be "drowned out." As the well goes through salt-water strata and there is some sulphur in the surface waters, this was believed to be the case. As a supposed remedy, new tubing was installed, protected by a japanned coating inside and outside, known as "Loricated" tubing. Photographs of this tubing, taken after thirty days' use, show numerous pit holes. The action was immediately diagnosed as electrolytic entirely, and was, of course, aggravated because a very slight defect in the coating concentrated electrolytic action at these spots, thus causing an aggravation instead of a remedy. To cure the trouble, careful observations were made as to the source of current, and a slight flow of current was found at all times with very heavy flows during the busy hours of the street car line. After installing the new tubing, several insulating joints were inserted in the casing in the hope that these will prove a remedy.

Pittsburg A. I. E. E. Meeting.

The monthly meeting of the Pittsburg branch of the American Institute of Electrical Engineers was held on December 12. The subject of the meeting was "Electrolysis," the programme having been arranged by the chairman, Mr. S. P. Grace. The principal speaker of the evening was Mr. E. E. Brownell. The following gentlemen each contributed five-minute discussions: Messrs. S. M. Kintner, on "Alternating-Current Electrolysis;" W. H. Fisher, "The Electrolysis Problem from the Cable Manufacturer's Standpoint;" F. Uhlenhaut, Jr., "What the Electric Railways are Doing to Prevent Electrolysis;" R. A. L. Snyder, "Electrolysis of Telephone Cables," and S. P. Grace, "The Ultimate Solution of the Electrolysis Problem." Mr. Brownell, who read the main paper, is a consulting engineer in Chicago, who has worked quietly during the past ten years for large gas and water companies throughout the country in the protection of their lines against electrolysis.

The Pittsburg section, of which Mr. S. P. Grace is chairman, is now in a very flourishing condition, and the meetings are well attended. It is expected that the interest will be still further increased this year, due to the fact that the new Carnegie Technical School has invited the section to hold its meetings in its new auditorium, and this meeting was held there.

Allowance for Depreciation at Holyoke, Mass.

We printed in our issue of December 16 the decision of the Board of Gas & Electric Light Commissioners of Massachusetts, refusing to allow a lower rate of depreciation on the Holyoke municipal gas plant. This decision, while final and governing, was not unanimous, Mr. Morris Schaffhaning filed a minority report. As this is interesting, in view of the importance of the subject of depreciation, we give it in full below:

The sole question involved in the petition for the board to consider is what is a fair rate of depreciation; in other words, what amount should the consumer pay in addition to cost, including interest on investment, for the gas or electricity the city supplies him. Obviously he must provide for the wear and tear, which is usually a charge in the operating expenses, but also such a sum yearly as will, if compounded, provide for a complete renewal of the property employed. When he has discharged this obligation, he has discharged all. He is not, in my judgment, to have to carry the burden for losses in litigation and over-values that the city was put to in buying the plant; that is for the whole municipality to bear, he as a taxpayer along with all other taxpayers. For it seems elementary that municipalities cannot make up out of a few, or a class of their citizens, losses that the city itself incurred, and which, as in this case, it could not have avoided—any principle of justice disapproves the application of such a theory. And it is equally consistent with reason that whatever view be taken of a consumer's obligation, the plant which is devoted to a public service for all time should have its cost distributed over as many years as may be wisely possible. It is unfair to consumers and taxpayers of to-day to not only pay, as they must, the bonds issued for the purchase price, but also a rate of depreciation in excess of the actual amount which experience has determined is necessary.

The logical effects of this decision are serious. For if, no matter how much more a municipality has to pay than the property is worth, it has to pay five per cent depreciation not only on the actual property, but on the excess of what it is worth, corporations inclined to a policy of high prices will feel themselves more strongly entrenched in their policy since the average man will hesitate between exorbitant prices and exorbitant taxation in the way of depreciation.

If it be sound policy for a consumer in a municipality to make up losses in purchase price, is it not a sound policy for a consumer of a private corporation to make up losses? Depreciation is an incident of physical things, and its limit for every part of a gas or electric plant is so well known that the determination of the amount in this case is all that is before the board; and the moment the board passes beyond that question it becomes a party to the question of public policy involved in municipal ownership. For the above reasons I dissent from the opinion of my colleagues.

Brush and Thomson at the Cleveland Club.

The Electric Club of Cleveland held a smoker on the evening of December 15 which was thoroughly enjoyed by a large number of members and their friends. In addition to music by a colored quartette, a "Dutch Lunch," etc., there was a special and unique feature which incidentally was considered as a joke on the majority of those present. The announcement stated that the meeting would be addressed by Mr. Charles F. Brush and Prof. Elihu Thomson, and a number attended with the expectations of meeting these gentlemen. As a matter of fact the addresses were delivered via a phonograph, and at the same time the phonograph was in operation, portraits of the speakers were thrown on the screen. The idea was conceived and carried out by Prof. E. P. Roberts, who was recently elected president of the club, and in order to embody the idea consistently Prof. Roberts introduced the speakers through the same medium.

In the course of his phonograph remarks, Mr. Brush said: "The old, old question, 'What is electricity,' is more to the front than ever before, but we need no longer make the old, unqualified and humiliating answer, 'we do not know.' We are now fairly on the way to finding out. The brilliant researches and speculations of J. J. Thompson, and others, seem pregnant with knowledge. We are told that the flying particles, or ether corpuscles of the Crooke's tube, are far smaller than the chemical atom; that their mass is little more than the thousandth part of that of the hydrogen atom; that they move with a velocity of the order of the velocity of light, and that each corpuscle carries a definite, and invariable, charge of negative electricity. Inasmuch as the corpuscle always carries the same charge, whatever gas is the source of the corpuscle, some physicists hold that the corpuscle consists wholly of electricity. If this view is correct, then electricity, or at least negative electricity, must be regarded as a form of matter, and not a phenomenon of the ether, as hitherto supposed, because the corpuscle is certainly endowed with the properties of mass and inertia, the most fundamental attributes of matter. The same physicists advance the hypothesis that all forms of mater are composed wholly of electrical corpuscles, grouped in various ways to form the chemical atom. This is an exceedingly interesting speculation, but cannot be verified or refuted until we know far more than we do now about positive electricity, and how it is associated with the negative corpuscle to form a neutral combination."

Prof. Elihu Thomson's remarks were as follows: "Were it not for the distance which separates us, and the time taken in going and coming, it would be better to greet the Cleveland Electric Club personally, and not by machine. Cleveland will always be associated with the pioneer work in series arc lighting by Mr. Charles F. Brush. The carbon industry remains as a testimony of his early work. We had then only the open carbon arc, and the volume of business done in the early eighties was not very large when com-

THE ELECTRICAL WORLD AND ENGINEER'S

MOONLIGHT TABLES FOR 1906

COMPILED BY H. W. FRUND

These schedules are made up on local mean time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made.

JANUARY, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.15 P.M.	2	6.00 A.M.	1	10.40 P.M.	2	6.20 A.M.
2	5.15 "	3	6.25 "	2	11.40 "	3	6.25 "
3	5.15 "	4	6.25 "	3	———	3	———
4	5.15 "	4	12.00 M.	4	12.35 A.M.	4	6.25 "
5	1.30 A.M.	5	6.25 A.M.	5	1.30 "	5	6.25 "
5	5.15 P.M.	5	12.00 M.	6	2.30 "	6	6.25 "
6	2.30 A.M.	6	6.25 A.M.	7	3.25 "	7	6.25 "
6	5.15 P.M.	6	12.00 M.	8	4.20 "	8	6.25 "
7	5.20 "	7	12.00 "	9	No light.	9	No light.
8	5.20 "	8	12.00 "	10	No light.	10	No light.
9	5.20 "	9	12.00 "	11	No light.	11	No light.
10	5.20 "	10	12.00 "	12	5.20 P.M.	12	8.10 P.M.
11	5.20 "	11	12.00 "	13	5.25 A.M.	13	9.15 "
12	5.20 "	12	12.00 "	14	5.25 "	14	10.20 "
13	5.25 "	13	12.00 "	15	5.25 "	15	11.30 "
14	5.25 "	14	12.00 "	16	5.25 "	17	12.35 A.M.
15	5.25 "	15	12.00 "	17	5.30 "	18	1.45 "
16	5.25 "	17	12.35 A.M.	18	5.30 "	19	2.50 "
17	5.30 "	18	1.45 "	19	5.30 "	20	4.00 "
18	5.30 "	19	2.50 "	20	5.30 "	21	5.10 "
19	5.30 "	20	4.00 "	21	5.35 "	22	6.15 "
20	5.30 "	21	5.10 "	22	5.35 "	23	6.15 "
21	5.35 "	22	6.15 "	23	5.35 "	24	6.15 "
22	5.35 "	23	6.15 "	24	5.35 "	25	6.15 "
23	5.35 "	24	6.15 "	25	5.35 "	26	6.15 "
24	5.35 "	25	6.15 "	26	5.35 "	27	6.15 "
25	5.35 "	26	6.15 "	27	5.40 "	28	6.15 "
26	5.35 "	27	6.15 "	28	5.40 "	29	6.15 "
27	5.40 "	28	6.15 "	29	9.25 "	30	6.15 "
28	5.40 "	29	6.15 "	30	10.25 "	31	6.15 "
29	5.45 "	30	6.15 "	31	11.20 "	1	6.10 "
31	5.46 "	1	6.10 "				

FEBRUARY, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.45 P.M.	2	6.10 A.M.	1	———	1	———
2	5.45 "	2	12.00 M.	2	12.15 A.M.	2	6.10 A.M.
3	1.10 A.M.	3	6.10 A.M.	3	1.10 "	3	6.10 "
3	5.50 P.M.	3	12.00 M.	4	2.05 "	4	6.10 "
4	2.05 A.M.	4	6.10 A.M.	5	3.00 "	5	6.10 "
4	5.50 P.M.	4	12.00 M.	6	4.00 "	6	6.10 "
5	3.00 A.M.	5	6.10 A.M.	7	No light.	7	No light.
5	5.50 P.M.	5	12.00 M.	8	No light.	8	No light.
6	5.50 "	6	12.00 "	9	No light.	9	No light.
7	5.55 "	7	12.00 "	10	5.55 P.M.	10	8.10 P.M.
8	5.55 "	8	12.00 "	11	6.00 "	11	9.20 "
9	5.55 "	9	12.00 "	12	6.00 "	12	10.30 "
10	5.55 "	10	12.00 "	13	6.00 "	13	11.40 "
11	6.00 "	11	12.00 "	14	6.00 "	15	12.50 A.M.
12	6.00 "	12	12.00 "	15	6.05 "	16	1.55 "
13	6.00 "	13	12.00 "	16	6.05 "	17	3.00 "
14	6.00 "	15	12.50 A.M.	17	6.05 "	18	4.05 "
15	6.05 "	16	1.55 "	18	6.05 "	19	5.00 "
16	6.05 "	17	3.00 "	19	6.10 "	20	5.50 "
17	6.05 "	18	4.05 "	20	6.10 "	21	5.50 "
18	6.05 "	19	5.00 "	21	6.10 "	22	5.45 "
19	6.10 "	20	5.50 "	22	6.10 "	24	5.45 "
20	6.10 "	21	5.50 "	23	6.10 "	25	5.40 "
21	6.10 "	22	5.50 "	24	6.15 "	26	5.40 "
22	6.10 "	23	5.45 "	25	6.15 "	28	5.40 "
23	6.10 "	24	5.45 "	26	6.15 "	1	5.35 "
24	6.15 "	25	5.45 "	27	6.15 "		
25	6.15 "	26	5.40 "	28	10.00 "		
26	6.15 "	27	5.40 "				
27	6.15 "	28	5.40 "				
28	6.20 "	1	5.35 "				

MARCH, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.20 P.M.	2	5.35 A.M.	1	11.00 P.M.	2	5.35 A.M.
2	6.20 "	3	5.35 "	2	11.55 "	3	5.35 "
3	6.20 "	4	5.35 "	3	———	3	———
4	6.20 "	4	12.00 M.	4	12.50 A.M.	4	5.35 A.M.
5	1.45 A.M.	5	5.30 A.M.	5	1.45 "	5	5.30 "
5	6.25 P.M.	5	12.00 M.	6	2.30 "	6	5.30 "
6	2.30 A.M.	6	5.30 A.M.	7	3.20 "	7	5.30 "
6	6.25 P.M.	6	12.00 M.	8	No light.	8	No light.
7	6.25 "	7	12.00 "	9	No light.	9	No light.
8	6.25 "	8	12.00 "	10	No light.	10	No light.
9	6.30 "	9	12.00 "	11	6.30 P.M.	11	8.10 P.M.
10	6.30 "	10	12.00 "	12	6.30 "	12	9.20 "
11	6.30 "	11	12.00 "	13	6.30 "	13	10.30 "
12	6.30 "	12	12.00 "	14	6.35 "	14	11.40 "
13	6.30 "	13	12.00 "	15	6.35 "	16	12.50 A.M.
14	6.35 "	14	12.00 "	16	6.35 "	17	2.00 "
15	6.35 "	16	12.50 A.M.	17	6.35 "	18	3.00 "
16	6.35 "	17	2.00 "	18	6.35 "	19	3.50 "
17	6.35 "	18	3.00 "	19	6.40 "	20	4.40 "
18	6.35 "	19	3.50 "	20	6.40 "	21	5.05 "
19	6.40 "	20	4.40 "	21	6.40 "	22	5.05 "
20	6.40 "	21	5.05 "	22	6.40 "	23	5.00 "
21	6.40 "	22	5.05 "	23	6.40 "	24	5.00 "
22	6.40 "	23	5.00 "	24	6.45 "	25	4.55 "
23	6.40 "	24	5.00 "	25	6.45 "	26	4.55 "
24	6.45 "	25	5.00 "	26	6.45 "	27	4.55 "
25	6.45 "	26	4.55 "	27	6.45 "	28	4.55 "
26	6.45 "	27	4.55 "	28	6.45 "	29	4.55 "
27	6.45 "	28	4.55 "	29	9.50 "	30	4.50 "
28	6.45 "	29	4.55 "	30	10.40 "	31	4 50 "
29	6.50 "	30	4.50 "	31	11.35 "	1	4.50 "
30	6.50 "	31	4.50 "				
31	6.50 "	1	4.50 "				

APRIL, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.50 P.M.	2	4.45 A.M.	1	———	1	———
2	6.50 "	2	12.00 M.	2	12.25 A.M.	2	4.45 A.M.
3	1.10 A.M.	3	4.45 A.M.	3	1.10 "	3	4.45 "
3	6.55 P.M.	3	12.00 M.	4	2.00 "	4	4.40 "
4	2.00 A.M.	4	4.40 A.M.	5	2.40 "	5	4.40 "
4	6.55 P.M.	4	12.00 M.	6	No light.	6	No light.
5	2.40 A.M.	5	4.40 A.M.	7	No light.	7	No light.
5	6.55 P.M.	5	12.00 M.	8	No light.	8	No light.
6	6.55 "	6	12.00 "	9	No light.	9	No light.
7	6.55 "	7	12.00 "	10	7.00 P.M.	10	9.25 P.M.
8	7.00 "	8	12.00 "	11	7.00 "	11	11.50 "
9	7.00 "	9	12.00 "	12	7.00 "	12	11.50 "
10	7.00 "	10	12.00 "	13	7.05 "	14	12.50 A.M.
11	7.00 "	11	12.00 "	14	7.05 "	15	1.50 "
12	7.00 "	12	12.00 "	15	7.05 "	16	2.40 "
13	7.05 "	14	12.50 A.M.	16	7.05 "	17	3.25 "
14	7.05 "	15	1.50 "	17	7.10 "	18	4.00 "
15	7.05 "	16	2.40 "	18	7.10 "	19	4.20 "
16	7.05 "	17	3.25 "	19	7.10 "	20	4.20 "
17	7.05 "	18	4.00 "	20	7.10 "	21	4.15 "
18	7.10 "	19	4.20 "	21	7.10 "	22	4.15 "
19	7.10 "	20	4.20 "	22	7.10 "	23	4.15 "
20	7.10 "	21	4.15 "	23	7.15 "	24	4.15 "
21	7.10 "	22	4.15 "	24	7.15 "	25	4.10 "
22	7.10 "	23	4.15 "	25	7.15 "	26	4.10 "
23	7.15 "	24	4.15 "	26	7.15 "	27	4.10 "
24	7.15 "	25	4.10 "	27	7.15 "	28	4.10 "
25	7.15 "	26	4.10 "	28	10.20 "	29	4.05 "
26	7.15 "	27	4.10 "	29	11.10 "	30	4.05 "
27	7.15 "	28	4.10 "	30	11.50 "	1	4.00 "
28	7.20 "	29	4.05 "				
29	7.20 "	30	4.05 "				
30	7.20 "	1	4.00 "				

MAY 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.20 P.M.	2	4.00 A.M.	1	———	1	———
2	7.20 "	2	12.00 M.	2	12.30 A.M.	2	4.00 A.M.
3	1.10 A.M.	3	4.00 A.M.	3	1.10 "	3	4.00 "
3	7.25 P.M.	3	12.00 M.	4	1.45 "	4	4.00 "
4	1.45 A.M.	4	4.00 A.M.	5	2.20 "	5	4.00 "
4	7.25 P.M.	4	12.00 M.	6	No light.	6	No light.
5	7.25 "	5	12.00 "	7	No light.	7	No light.
6	7.25 "	6	12.00 "	8	No light.	8	No light.
7	7.25 "	7	12.00 "	9	7.30 P.M.	9	9.30 P.M.
8	7.30 "	8	12.00 "	10	7.30 "	10	10.40 "
9	7.30 "	9	12.00 "	11	7.30 "	11	11.40 "
10	7.30 "	10	12.00 "	12	7.30 "	13	12.40 A.M.
11	7.30 "	11	12.00 "	13	7.35 "	14	1.25 "
12	7.30 "	13	12.40 A.M.	14	7.35 "	15	2.00 "
13	7.35 "	14	1.25 "	15	7.35 "	16	2.40 "
14	7.35 "	15	2.00 "	16	7.35 "	17	3.10 "
15	7.35 "	16	2.40 "	17	7.35 "	18	3.40 "
16	7.35 "	17	3.10 "	18	7.40 "	19	3.45 "
17	7.35 "	18	3.40 "	19	7.40 "	20	3.45 "
18	7.40 "	19	3.45 "	20	7.40 "	21	3.45 "
19	7.40 "	20	3.45 "	21	7.40 "	22	3.40 "
20	7.40 "	21	3.45 "	22	7.40 "	23	3.40 "
21	7.40 "	22	3.40 "	23	7.40 "	24	3.40 "
22	7.40 "	23	3.40 "	24	7.45 "	25	3.40 "
23	7.40 "	24	3.40 "	25	7.45 "	26	3.40 "
24	7.45 "	25	3.40 "	26	7.45 "	27	3.40 "
25	7.45 "	26	3.40 "	27	7.45 "	28	3.40 "
26	7.45 "	27	3.40 "	28	10.35 "	29	3.40 "
27	7.45 "	28	3.40 "	29	11.10 "	30	3.35 "
28	7.45 "	29	3.40 "	30	11.45 "	31	3.35 "
29	7.45 "	30	3.35 "	31	———	31	———
30	7.45 "	31	3.35 "				
31	7.50 "	1	3.35 "				

JUNE, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.50 P.M.	1	12.00 M.	1	12.20 A.M.	1	3.35 A.M.
2	12.55 A.M.	2	3.35 A.M.	2	12.55 "	2	3.35 "
2	7.50 P.M.	2	12.00 M.	3	1.30 "	3	3.35 "
3	7.50 "	3	12.00 "	4	No light.	4	No light.
4	7.50 "	4	12.00 "	5	No light.	5	No light.
5	7.50 "	5	12.00 "	6	No light.	6	No light.
6	7.55 "	6	12.00 "	7	7.55 P.M.	7	9.20 P.M.
7	7.55 "	7	12.00 "	8	7.55 "	8	10.20 "
8	7.55 "	8	12.00 "	9	7.55 "	9	11.15 "
9	7.55 "	9	12.00 "	10	7.55 "	10	12.00 M.
10	7.55 "	10	12.00 "	11	7.55 "	12	12.40 A.M.
11	7.55 "	12	12.40 A.M.	12	7.55 "	13	1.15 "
12	7.55 "	13	1.15 "	13	7.55 "	14	1.45 "
13	7.55 "	14	1.45 "	14	7.55 "	15	2.10 "
14	7.55 "	15	2.10 "	15	7.55 "	16	2.40 "
15	7.55 "	16	2.40 "	16	7.55 "	17	3.10 "
16	7.55 "	17	3.10 "	17	8.00 "	18	3.30 "
17	7.55 "	18	3.30 "	18	8.00 "	19	3.30 "
18	8.00 "	19	3.30 "	19	8.00 "	20	3.30 "
19	8.00 "	20	3.30 "	20	8.00 "	21	3.30 "
20	8.00 "	21	3.30 "	21	8.00 "	22	3.30 "
21	8.00 "	22	3.30 "	22	8.00 "	23	3.30 "
22	8.00 "	23	3.30 "	23	8.00 "	24	3.30 "
23	8.00 "	24	3.30 "	24	8.00 "	25	3.30 "
24	8.00 "	25	3.30 "	25	8.00 "	26	3.30 "
25	8.00 "	26	3.30 "	26	9.50 "	27	3.30 "
26	8.00 "	27	3.30 "	27	10.20 "	28	3.30 "
27	8.00 "	28	3.30 "	28	11.00 "	29	3.30 "
28	8.00 "	29	3.30 "	29	11.30 "	30	3.30 "
29	8.00 "	30	3.30 "	30	12.00 M.	1	3.35 "
30	8.00 "	1	3.35 "				

JULY, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Light.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	2	3.35 A.M.	1	———	—	———
2	8.00 "	2	12.00 M.	2	12.40 A.M.	2	3.35 A.M.
3	8.00 "	3	12.00 "	3	1.20 "	3	3.35 A.M.
4	8.00 "	4	12.00 "	4	No light.	4	No light.
5	8.00 "	5	12.00 "	5	No light.	5	No light.
6	8.00 "	6	12.00 "	6	No light.	6	No light.
7	8.00 "	7	12.00 "	7	8.00 P.M.	7	10.00 P.M.
8	8.00 "	8	12.00 "	8	8.00 "	8	10.35 "
9	8.00 "	9	12.00 "	9	8.00 "	9	11.10 "
10	8.00 "	10	12.00 "	10	8.00 "	10	11.40 "
11	8.00 "	11	12.00 "	11	8.00 "	12	12.10 A.M.
12	8.00 "	13	12.40 A.M.	12	8.00 "	13	12.40 "
13	8.00 "	14	1.10 "	13	8.00 "	14	1.10 "
14	8.00 "	15	1.40 "	14	8.00 "	15	1.40 "
15	8.00 "	16	2.10 "	15	8.00 "	16	2.10 "
16	8.00 "	17	2.45 "	16	8.00 "	17	2.45 "
17	8.00 "	18	3.25 "	17	8.00 "	18	3.25 "
18	8.00 "	19	3.45 "	18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "	19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "	20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "	21	7.55 "	22	3.45 "
22	7.55 "	23	3.45 "	22	7.55 "	23	3.45 "
23	7.55 "	24	3.45 "	23	7.55 "	24	3.45 "
24	7.55 "	25	3.45 "	24	7.55 "	25	3.50 "
25	7.55 "	26	3.50 "	25	7.55 "	26	3.50 "
26	7.50 "	27	3.50 "	26	9.30 "	27	3.50 "
27	7.50 "	28	3.50 "	27	10.05 "	28	3.50 "
28	7.50 "	29	3.50 "	28	10.40 "	29	3.50 "
29	7.50 "	30	3.50 "	29	11.20 "	30	3.55 "
30	7.50 "	31	3.50 "	30	12.00 M.	31	3.55 "
31	7.45 "	31	12.00 M.	31	———	—	———

AUGUST, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Light.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.	1	12.50 A.M.	1	3.55 A.M.
2	7.45 "	2	12.00 "	2	1.50 "	2	4.00 "
3	7.45 "	3	12.00 "	3	No light.	3	No light.
4	7.45 "	4	12.00 "	4	No light.	4	No light.
5	7.40 "	5	12.00 "	5	7.40 P.M.	5	9.10 P.M.
6	7.40 "	6	12.00 "	6	7.40 "	6	9.40 "
7	7.40 "	7	12.00 "	7	7.40 "	7	10.45 "
8	7.40 "	8	12.00 "	8	7.40 "	8	11.10 "
9	7.40 "	9	12.00 "	9	7.40 "	9	11.40 "
10	7.35 "	10	12.00 "	10	7.35 "	11	12.10 A.M.
11	7.35 "	12	12.40 A.M.	11	7.35 "	12	12.40 "
12	7.35 "	13	1.20 "	12	7.35 "	13	1.20 "
13	7.30 "	14	2.00 "	13	7.30 "	14	2.00 "
14	7.30 "	15	2.50 "	14	7.30 "	15	2.50 "
15	7.30 "	16	3.40 "	15	7.30 "	16	3.40 "
16	7.25 "	17	4.15 "	16	7.25 "	17	4.15 "
17	7.25 "	18	4.15 "	17	7.25 "	18	4.15 "
18	7.25 "	19	4.15 "	18	7.25 "	19	4.15 "
19	7.25 "	20	4.15 "	19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "	20	7.20 "	21	4.15 "
21	7.20 "	22	4.15 "	21	7.20 "	22	4.15 "
22	7.20 "	23	4.15 "	22	7.20 "	23	4.15 "
23	7.20 "	24	4.15 "	23	7.20 "	24	4.15 "
24	7.15 "	25	4.20 "	24	8.40 "	25	4.20 "
25	7.15 "	26	4.20 "	25	9.20 "	26	4.20 "
26	7.15 "	27	4.20 "	26	10.00 "	27	4.20 "
27	7.15 "	28	4.20 "	27	10.45 "	28	4.20 "
28	7.10 "	29	4.25 "	28	11.40 "	29	4.25 "
29	7.10 "	29	12.00 M.	29	———	—	———
30	7.10 "	30	12.00 "	30	12.40 A.M.	30	4.25 "
31	7.05 "	31	12.00 "	31	1.40 "	31	4.25 "

SEPTEMBER, 1906

Table No. 1. Frund's Moon light System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.	1	2.45 A.M.	1	4.25 A.M.
2	7.05 "	2	12.00 "	2	No light.	2	No light.
3	7.00 "	3	12.00 "	3	No light.	3	No light.
4	7.00 "	4	12.00 "	4	7.00 P.M.	4	8.45 P.M.
5	7.00 "	5	12.00 "	5	7.00 "	5	9.10 "
6	6.55 "	6	12.00 "	6	6.55 "	6	9.40 "
7	6.55 "	7	12.00 "	7	6.55 "	7	10.10 "
8	6.55 "	8	12.00 "	8	6.55 "	8	10.40 "
9	6.50 "	9	12.00 "	9	6.50 "	9	11.15 "
10	6.50 "	10	12.00 "	10	6.50 "	10	11.55 "
11	6.50 "	12	12.40 A.M.	11	6.50 "	12	12.40 A.M.
12	6.45 "	13	1.30 "	12	6.45 "	13	1.30 "
13	6.45 "	14	2.20 "	13	6.45 "	14	2.20 "
14	6.45 "	15	3.20 "	14	6.45 "	15	3.20 "
15	6.45 "	16	4.20 "	15	6.45 "	16	4.20 "
16	6.40 "	17	4.40 "	16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "	17	6.40 "	18	4.40 "
18	6.40 "	19	4.40 "	18	6.40 "	19	4.40 "
19	6.35 "	20	4.40 "	19	6.35 "	20	4.40 "
20	6.35 "	21	4.40 "	20	6.35 "	21	4.40 "
21	6.35 "	22	4.45 "	21	6.35 "	22	4.45 "
22	6.30 "	23	4.45 "	22	6.30 "	23	4.45 "
23	6.30 "	24	4.45 "	23	8.40 "	24	4.45 "
24	6.25 "	25	4.45 "	24	9.40 "	25	4.45 "
25	6.25 "	26	4.50 "	25	10.30 "	26	4.50 "
26	6.25 "	27	4.50 "	26	11.30 "	27	4.50 "
27	6.20 "	28	4.50 "	27	———	—	———
28	6.20 "	28	12.00 M.	28	12.35 A.M.	28	4.50 A.M.
29	6.20 "	29	12.00 "	29	1.40 "	29	4.50 "
30	6.15 "	30	12.00 "	30	2.40 "	30	4.50 "

OCTOBER, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.

NOVEMBER, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.

DECEMBER, 1906

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.05 P.M.	1	12.00 M.	1	No light.	1	No light.

Date.	Light.	Date.	Exting.
10	5.20 "	10	12.00 "
11	5.20 "	11	12.00 "
12	5.20 "	12	12.00 "
13	5.25 "	13	12.00 "
14	5.25 "	14	12.00 "
15	5.25 "	15	12.00 "
16	5.25 "	17	12.35 A.M.
17	5.30 "	18	1.45 "
18	5.30 "	19	2.50 "
19	5.30 "	20	4.00 "
20	5.30 "	21	5.10 "
21	5.35 "	22	6.15 "
22	5.35 "	23	6.15 "
23	5.35 "	24	6.15 "
24	5.35 "	25	6.15 "
25	5.35 "	26	6.15 "
26	5.35 "	27	6.15 "
27	5.40 "	28	6.15 "
28	5.40 "	29	6.15 "
29	5.45 "	30	6.15 "
31	5.46 "	1	6.10 "

Date.	Light.	Date.	Exting.
12	5.20 P.M.	12	8.10 P.M.
13	5.25 A.M.	13	9.15 "
14	5.25 "	14	10.20 "
15	5.25 "	15	11.30 "
16	5.25 "	17	12.35 A.M.
17	5.30 "	18	1.45 "
18	5.30 "	19	2.50 "
19	5.30 "	20	4.00 "
20	5.30 "	21	5.10 "
21	5.35 "	22	6.15 "
22	5.35 "	23	6.15 "
23	5.35 "	24	6.15 "
24	5.35 "	25	6.15 "
25	5.35 "	26	6.15 "
26	5.35 "	27	6.15 "
27	5.40 "	28	6.15 "
28	5.40 "	29	6.15 "
29	9.25 "	30	6.15 "
30	10.25 "	31	6.15 "
31	11.20 "	1	6.10 "

Date.	Light.	Date.	Exting.
9	5.55 "	9	12.00 "
10	5.55 "	10	12.00 "
11	6.00 "	11	12.00 "
12	6.00 "	12	12.00 "
13	6.00 "	13	12.00 "
14	6.00 "	15	1.55 "
15	6.05 "	16	1.55 "
16	6.05 "	17	3.00 "
17	6.05 "	18	4.05 "
18	6.05 "	19	5.00 "
19	6.10 "	20	5.50 "
20	6.10 "	21	5.50 "
21	6.10 "	22	5.50 "
22	6.10 "	23	5.45 "
23	6.10 "	24	5.45 "
24	6.15 "	25	5.45 "
25	6.15 "	26	5.40 "
26	6.15 "	27	5.40 "
27	6.15 "	28	5.40 "
28	6.20 "	1	5.35 "

Date.	Light.	Date.	Exting.
12	6.00 "	12	10.30 "
13	6.00 "	13	11.40 "
14	6.00 "	15	12.50 A.M.
15	6.05 "	16	1.55 "
16	6.05 "	17	3.00 "
17	6.05 "	18	4.05 "
18	6.05 "	19	5.00 "
19	6.10 "	20	5.50 "
20	6.10 "	21	5.50 "
21	6.10 "	22	5.50 "
22	6.10 "	23	5.45 "
23	6.10 "	24	5.45 "
24	6.15 "	25	5.45 "
25	6.15 "	26	5.40 "
26	6.15 "	27	5.40 "
27	6.15 "	28	5.40 "
28	10.00 "	1	5.35 "

Date.	Light.	Date.	Exting.
10	6.30 "	10	12.00 "
11	6.30 "	11	12.00 "
12	6.30 "	12	12.00 "
13	6.30 "	13	12.00 "
14	6.35 "	14	12.00 "
15	6.35 "	16	12.50 A.M.
16	6.35 "	17	2.00 "
17	6.35 "	18	3.00 "
18	6.35 "	19	3.50 "
19	6.40 "	20	4.40 "
20	6.40 "	21	5.05 "
21	6.40 "	22	5.05 "
22	6.40 "	23	5.00 "
23	6.40 "	24	5.00 "
24	6.45 "	25	5.00 "
25	6.45 "	26	4.55 "
26	6.45 "	27	4.55 "
27	6.45 "	28	4.55 "
28	6.45 "	29	4.55 "
29	6.58 "	30	4.50 "
30	6.50 "	31	4.50 "
31	6.50 "	1	4.50 "

Date.	Light.	Date.	Exting.
12	6.30 "	12	9.20 "
13	6.30 "	13	10.30 "
14	6.35 "	14	11.40 "
15	6.35 "	16	12.50 A.M.
16	6.35 "	17	2.00 "
17	6.35 "	18	3.00 "
18	6.35 "	19	3.50 "
19	6.40 "	20	4.40 "
20	6.40 "	21	5.05 "
21	6.40 "	22	5.05 "
22	6.40 "	23	5.00 "
23	6.40 "	24	5.00 "
24	6.45 "	25	5.00 "
25	6.45 "	26	4.55 "
26	6.45 "	27	4.55 "
27	6.45 "	28	4.55 "
28	6.45 "	29	4.55 "
29	6.58 "	30	4.50 "
30	6.50 "	31	4.50 "
31	6.50 "	1	4.50 "

APRIL, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	6.50 P.M.	2	4.45 A.M.
2	6.50 "	2	12.50 M.
3	1.10 A.M.	3	4.45 A.M.
3	6.55 P.M.	3	12.00 M.
4	2.00 A.M.	4	4.40 A.M.
4	6.55 P.M.	4	12.00 M.
5	2.40 A.M.	5	4.40 A.M.
5	6.55 P.M.	5	12.00 M.
6	6.55 "	6	12.00 "
7	6.55 "	7	12.00 "
8	7.00 "	8	12.00 "
9	7.00 "	9	12.00 "
10	7.00 "	10	12.00 "
11	7.00 "	11	12.00 "
12	7.00 "	12	12.00 "
13	7.05 "	14	12.50 A.M.
14	7.05 "	15	1.50 "
15	7.05 "	16	2.40 "
16	7.05 "	17	3.25 "
17	7.10 "	18	4.00 "
18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "
21	7.10 "	22	4.15 "
22	7.10 "	23	4.15 "
23	7.15 "	24	4.15 "
24	7.15 "	25	4.10 "
25	7.15 "	26	4.10 "
26	7.15 "	27	4.10 "
27	7.15 "	28	4.10 "
28	7.20 "	29	4.05 "
29	7.20 "	30	4.05 "
30	7.20 "	1	4.00 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	——	1	——
2	12.25 A.M.	2	4.45 A.M.
3	1.10 "	3	4.45 "
4	2.00 "	4	4.40 "
5	2.40 "	5	4.40 "
6	No light.	6	No light.
7	No light.	7	No light.
8	No light.	8	No light.
9	No light.	9	No light.
10	7.00 P.M.	10	9.25 P.M.
11	7.00 "	11	11.50 "
12	7.00 "	12	11.50 "
13	7.05 "	14	12.50 A.M.
14	7.05 "	15	1.50 "
15	7.05 "	16	2.40 "
16	7.05 "	17	3.25 "
17	7.10 "	18	4.00 "
18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "
21	7.10 "	22	4.15 "
22	7.10 "	23	4.15 "
23	7.15 "	24	4.15 "
24	7.15 "	25	4.10 "
25	7.15 "	26	4.10 "
26	7.15 "	27	4.10 "
27	7.15 "	28	4.10 "
28	10.20 "	29	4.05 "
29	11.10 "	30	4.05 "
30	11.50 "	1	4.00 "

MAY 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.20 P.M.	2	4.00 A.M.
2	7.20 "	2	12.00 M.
3	1.10 A.M.	3	4.00 A.M.
3	7.25 P.M.	3	12.00 M.
4	1.45 A.M.	4	4.00 A.M.
4	7.25 P.M.	4	12.00 M.
5	7.25 "	5	12.00 "
6	7.25 "	6	12.00 "
7	7.25 "	7	12.00 "
8	7.30 "	8	12.00 "
9	7.30 "	9	12.00 "
10	7.30 "	10	12.00 "
11	7.30 "	11	12.00 "
12	7.30 "	13	12.40 A.M.
13	7.35 "	14	1.25 "
14	7.35 "	15	2.00 "
15	7.35 "	16	2.40 "
16	7.35 "	17	3.10 "
17	7.35 "	18	3.40 "
18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "
20	7.40 "	21	3.45 "
21	7.40 "	22	3.40 "
22	7.40 "	23	3.40 "
23	7.40 "	24	3.40 "
24	7.45 "	25	3.40 "
25	7.45 "	26	3.40 "
26	7.45 "	27	3.40 "
27	7.45 "	28	3.40 "
28	7.45 "	29	3.40 "
29	7.45 "	30	3.35 "
30	7.45 "	31	3.35 "
31	7.50 "	1	3.35

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	——	1	——
2	12.30 A.M.	2	4.00 A.M.
3	1.10 "	3	4.00 "
4	1.45 "	4	4.00 "
5	2.20 "	5	4.00 "
6	No light.	6	No light.
7	No light.	7	No light.
8	No light.	8	No light.
9	7.30 P.M.	9	9.30 P.M.
10	7.30 "	10	10.40 "
11	7.30 "	11	11.40 "
12	7.30 "	13	12.40 A.M.
13	7.35 "	14	1.25 "
14	7.35 "	15	2.00 "
15	7.35 "	16	2.40 "
16	7.35 "	17	3.10 "
17	7.35 "	18	3.40 "
18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "
20	7.40 "	21	3.45 "
21	7.40 "	22	3.40 "
22	7.40 "	23	3.40 "
23	7.40 "	24	3.40 "
24	7.45 "	25	3.40 "
25	7.45 "	26	3.40 "
26	7.45 "	27	3.40 "
27	7.45 "	28	3.40 "
28	10.35 "	29	3.40 "
29	11.10 "	30	3.35 "
30	11.45 "	31	3.35 "
31	——	31	——

JUNE, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	7.50 P.M.	1	12.00 M.
2	12.55 A.M.	2	3.35 A.M.
2	7.50 P.M.	2	12.00 M.
3	7.50 "	3	12.00 "
4	7.50 "	4	12.00 "
5	7.50 "	5	12.00 "
6	7.55 "	6	12.00 "
7	7.55 "	7	12.00 "
8	7.55 "	8	12.00 "
9	7.55 "	9	12.00 "
10	7.55 "	10	12.00 "
11	7.55 "	12	12.40 A.M.
12	7.55 "	13	1.15 "
13	7.55 "	14	1.45 "
14	7.55 "	15	2.10 "
15	7.55 "	16	2.40 "
16	7.55 "	17	3.10 "
17	7.55 "	18	3.30 "
18	8.00 "	19	3.30 "
19	8.00 "	20	3.30 "
20	8.00 "	21	3.30 "
21	8.00 "	22	3.30 "
22	8.00 "	23	3.30 "
23	8.00 "	24	3.30 "
24	8.00 "	25	3.30 "
25	8.00 "	26	3.30 "
26	8.00 "	27	3.30 "
27	8.00 "	28	3.30 "
28	8.00 "	29	3.30 "
29	8.00 "	30	3.30 "
30	8.00 "	1	3.35 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	12.20 A.M.	1	3.35 A.M.
2	12.55 "	2	3.35 "
3	1.30 "	3	3.35 "
4	No light.	4	No light.
5	No light.	5	No light.
6	No light.	6	No light.
7	7.55 P.M.	7	9.20 P.M.
8	7.55 "	8	10.20 "
9	7.55 "	9	11.15 "
10	7.55 "	10	12.00 M.
11	7.55 "	12	12.40 A.M.
12	7.55 "	13	1.15 "
13	7.55 "	14	1.45 "
14	7.55 "	15	2.10 "
15	7.55 "	16	2.40 "
16	7.55 "	17	3.10 "
17	8.00 "	18	3.30 "
18	8.00 "	19	3.30 "
19	8.00 "	20	3.30 "
20	8.00 "	21	3.30 "
21	8.00 "	22	3.30 "
22	8.00 "	23	3.30 "
23	8.00 "	24	3.30 "
24	8.00 "	25	3.30 "
25	8.00 "	26	3.30 "
26	9.50 "	27	3.30 "
27	10.20 "	28	3.30 "
28	11.00 "	29	3.30 "
29	11.30 "	30	3.30 "
30	12.00 M.	1	3.35 "

JULY, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Light.
1	8.00 P.M.	2	3.35 A.M.
2	8.00 "	2	12.00 M.
3	8.00 "	3	12.00 "
4	8.00 "	4	12.00 "
5	8.00 "	5	12.00 "
6	8.00 "	6	12.00 "
7	8.00 "	7	12.00 "
8	8.00 "	8	12.00 "
9	8.00 "	9	12.00 "
10	8.00 "	10	12.00 "
11	8.00 "	11	12.00 "
12	8.00 "	13	12.40 A.M.
13	8.00 "	14	1.10 "
14	8.00 "	15	1.40 "
15	8.00 "	16	2.10 "
16	8.00 "	17	2.45 "
17	8.00 "	18	3.25 "
18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "
22	7.55 "	23	3.45 "
23	7.55 "	24	3.45 "
24	7.55 "	25	3.45 "
25	7.55 "	26	3.50 "
26	7.50 "	27	3.50 "
27	7.50 "	28	3.50 "
28	7.50 "	29	3.50 "
29	7.50 "	30	3.50 "
30	7.50 "	31	3.50 "
31	7.45 "	31	12.00 M.

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	——	—	——
2	12.40 A.M.	2	3.35 A.M.
3	1.20 "	3	3.35 A.M.
4	No light.	4	No light.
5	No light.	5	No light.
6	No light.	6	No light.
7	8.00 P.M.	7	10.00 P.M.
8	8.00 "	8	10.35 "
9	8.00 "	9	11.10 "
10	8.00 "	10	11.40 "
11	8.00 "	12	12.10 A.M.
12	8.00 "	13	12.40 "
13	8.00 "	14	1.10 "
14	8.00 "	15	1.40 "
15	8.00 "	16	2.10 "
16	8.00 "	17	2.45 "
17	8.00 "	18	3.25 "
18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "
22	7.55 "	23	3.45 "
23	7.55 "	24	3.45 "
24	7.55 "	25	3.50 "
25	7.55 "	26	3.50 "
26	9.30 "	27	3.50 "
27	10.05 "	28	3.50 "
28	10.40 "	29	3.50 "
29	11.20 "	30	3.55 "
30	12.00 M.	31	3.55 "
31	——	—	——

AUGUST, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Light.
1	7.45 P.M.	1	12.00 M.
2	7.45 "	2	12.00 "
3	7.45 "	3	12.00 "
4	7.45 "	4	12.00 "
5	7.40 "	5	12.00 "
6	7.40 "	6	12.00 "
7	7.40 "	7	12.00 "
8	7.40 "	8	12.00 "
9	7.40 "	9	12.00 "
10	7.35 "	10	12.00 "
11	7.35 "	12	12.40 A.M.
12	7.35 "	13	1.20 "
13	7.30 "	14	2.00 "
14	7.30 "	15	2.50 "
15	7.30 "	16	3.40 "
16	7.25 "	17	4.15 "
17	7.25 "	18	4.15 "
18	7.25 "	19	4.15 "
19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "
21	7.20 "	22	4.15 "
22	7.20 "	23	4.15 "
23	7.20 "	24	4.15 "
24	7.15 "	25	4.20 "
25	7.15 "	26	4.20 "
26	7.15 "	27	4.20 "
27	7.15 "	28	4.20 "
28	7.10 "	29	4.25 "
29	7.10 "	29	12.00 M.
30	7.10 "	30	12.00 "
31	7.05 "	31	12.00 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	12.50 A.M.	1	3.55 A.M.
2	1.50 "	2	4.00 "
3	No light.	3	No light.
4	No light.	4	No light.
5	7.40 P.M.	5	9.10 P.M.
6	7.40 "	6	9.40 "
7	7.40 "	7	10.45 "
8	7.40 "	8	11.10 "
9	7.40 "	9	11.40 "
10	7.35 "	11	12.10 A.M.
11	7.35 "	12	12.40 "
12	7.35 "	13	1.20 "
13	7.30 "	14	2.00 "
14	7.30 "	15	2.50 "
15	7.30 "	16	3.40 "
16	7.25 "	17	4.15 "
17	7.25 "	18	4.15 "
18	7.25 "	19	4.15 "
19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "
21	7.20 "	22	4.15 "
22	7.20 "	23	4.15 "
23	7.20 "	24	4.15 "
24	8.40 "	25	4.20 "
25	9.20 "	26	4.20 "
26	10.00 "	27	4.20 "
27	10.45 "	28	4.20 "
28	11.40 "	29	4.25 "
29	——	—	——
30	12.40 A.M.	30	4.25 "
31	1.40 "	31	4.25 "

SEPTEMBER, 1906

Table No. 1. Frund's Moon light System.

Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.
2	7.05 "	2	12.00 "
3	7.00 "	3	12.00 "
4	7.00 "	4	12.00 "
5	7.00 "	5	12.00 "
6	6.55 "	6	12.00 "
7	6.55 "	7	12.00 "
8	6.55 "	8	12.00 "
9	6.50 "	9	12.00 "
10	6.50 "	10	12.00 "
11	6.50 "	12	12.40 A.M.
12	6.45 "	13	1.30 "
13	6.45 "	14	2.20 "
14	6.45 "	15	3.20 "
15	6.45 "	16	4.20 "
16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "
18	6.40 "	19	4.40 "
19	6.35 "	20	4.40 "
20	6.35 "	21	4.40 "
21	6.35 "	22	4.45 "
22	6.30 "	23	4.45 "
23	6.30 "	24	4.45 "
24	6.25 "	25	4.45 "
25	6.25 "	26	4.50 "
26	6.25 "	27	4.50 "
27	6.20 "	28	4.50 "
28	6.20 "	28	12.00 M.
29	6.20 "	29	12.00 "
30	6.15 "	30	12.00 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	2.45 A.M.	1	4.25 A.M.
2	No light.	2	No light.
3	No light.	3	No light.
4	7.00 P.M.	4	8.45 P.M.
5	7.00 "	5	9.10 "
6	6.55 "	6	9.40 "
7	6.55 "	7	10.10 "
8	6.55 "	8	10.40 "
9	6.50 "	9	11.15 "
10	6.50 "	10	11.55 "
11	6.50 "	12	12.40 A.M.
12	6.45 "	13	1.30 "
13	6.45 "	14	2.20 "
14	6.45 "	15	3.20 "
15	6.45 "	16	4.20 "
16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "
18	6.40 "	19	4.40 "
19	6.35 "	20	4.40 "
20	6.35 "	21	4.40 "
21	6.35 "	22	4.45 "
22	6.30 "	23	4.45 "
23	8.40 "	24	4.45 "
24	9.40 "	25	4.45 "
25	10.30 "	26	4.50 "
26	11.30 "	27	4.50 "
27	——	—	——
28	12.35 A.M.	28	4.50 A.M.
29	1.40 "	29	4.50 "
30	2.40 "	30	4.50 "

OCTOBER, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	12.00 M.
2	6.15 "	2	12.00 "
3	6.15 "	3	12.00 "
4	6.10 "	4	12.00 "
5	6.10 "	5	12.00 "
6	6.10 "	6	12.00 "
7	6.05 "	7	12.00 "
8	6.05 "	8	12.00 "
9	6.05 "	9	12.00 "
10	6.00 "	10	12.00 "
11	6.00 "	11	1.05 A.M.
12	6.00 "	13	2.05 "
13	5.55 "	14	3.10 "
14	5.55 "	15	4.15 "
15	5.55 "	16	5.10 "
16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "
18	5.50 "	19	5.10 "
19	5.50 "	20	5.10 "
20	5.45 "	21	5.15 "
21	5.45 "	22	5.15 "
22	5.45 "	23	5.15 "
23	5.45 "	24	5.15 "
24	5.40 "	25	5.15 "
25	5.40 "	26	5.20 "
26	5.40 "	27	5.20 "
27	5.35 "	27	12.00 M.
28	5.35 "	28	12.00 "
29	5.35 "	29	12.00 "
30	5.35 "	30	12.00 "
31	5.30 "	31	12.00 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No light.	1	No light.
2	No light.	2	No light.
3	No light.	3	No light.
4	6.10 P.M.	4	8.10 P.M.
5	6.10 "	5	8.40 "
6	6.10 "	6	9.15 "
7	6.05 "	7	9.50 "
8	6.05 "	8	10.30 "
9	6.05 "	9	11.20 "
10	6.00 "	11	12.10 A.M.
11	6.00 "	12	1.05 "
12	6.00 "	13	2.05 "
13	5.55 "	14	3.10 "
14	5.55 "	15	4.15 "
15	5.55 "	16	5.10 "
16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "
18	5.50 "	19	5.10 "
19	5.50 "	20	5.10 "
20	5.45 "	21	5.15 "
21	5.45 "	22	5.15 "
22	8.25 "	23	5.15 "
23	9.25 "	24	5.15 "
24	10.30 "	25	5.15 "
25	11.30 "	26	5.20 "
26	——	26	——
27	12.40 A.M.	27	5.20 A.M.
28	1.40 "	28	5.20 "
29	2.40 "	29	5.25 "
30	3.40 "	30	5.25 "
31	No light.	31	No light.

NOVEMBER, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.30 P.M.	1	12.00 M.
2	5.30 "	2	12.00 "
3	5.30 "	3	12.00 "
4	5.25 "	4	12.00 "
5	5.25 "	5	12.00 "
6	5.25 "	6	12.00 "
7	5.25 "	7	12.00 "
8	5.25 "	8	12.00 "
9	5.20 "	10	12.50 A.M.
10	5.20 "	11	1.50 "
11	5.20 "	12	3.00 "
12	5.20 "	13	4.10 "
13	5.20 "	14	5.20 "
14	5.20 "	15	5.45 "
15	5.15 "	16	5.45 "
16	5.15 "	17	5.45 "
17	5.15 "	18	5.45 "
18	5.15 "	19	5.45 "
19	5.15 "	20	5.45 "
20	5.15 "	21	5.50 "
21	5.10 "	22	5.50 "
22	5.10 "	23	5.50 "
23	5.10 "	24	5.50 "
24	5.10 "	25	5.50 "
25	5.10 "	25	12.00 M.
26	1.35 A.M.	26	5.55 A.M.
26	5.10 P.M.	26	12.00 A.M.
27	5.10 "	27	12.00 "
28	5.10 "	28	12.00 "
29	5.10 "	29	12.00 "
30	5.10 "	30	12.00 "

Table No. 2. Standard Moonlight System.

Date.	Light.	Date.	Exting.
1	No light.	1	No light.
2	No light.	2	No light.
3	5.25 P.M.	3	7.50 P.M.
4	5.20 "	4	8.30 "
5	5.20 "	5	9.10 "
6	5.20 "	6	10.00 "
7	5.20 "	7	11.00 "
8	5.20 "	8	11.50 "
9	5.15 "	10	12.50 A.M.
10	5.15 "	11	1.50 "
11	5.15 "	12	3.00 "
12	5.15 "	13	4.10 "
13	5.15 "	14	5.20 "
14	5.10 "	15	5.45 "
15	5.10 "	16	5.45 "
16	5.10 "	17	5.45 "
17	5.10 "	18	5.45 "
18	5.10 "	19	5.45 "
19	5.10 "	20	5.45 "
20	5.10 "	21	5.50 "
21	9.20 "	22	5.50 "
22	10.30 "	23	5.50 "
23	11.30 "	24	5.50 "
24	——	24	——
25	12.30 A.M.	25	5.50 A.M.
26	1.35 "	26	5.55 "
27	2.35 "	27	5.55 "
28	3.30 "	28	5.55 "
29	4.30 "	29	6.00 "
30	No light.	30	No light.

DECEMBER, 1906

Table No. 1. Frund's Moonlight System.

Date.	Light.	Date.	Exting.
1	5.05 P.M.	1	12.00 M.
2	5.05 "	2	12.00 "
3	5.05 "	3

pared with that of arc lighting alone in recent years. Now we have many forms of arc light, series and constant potential, open and enclosed, carbon crater, luminous flame and mercury arc, varying in adaptability and efficiency. What we have to look forward to, is higher efficiency of light production. We now waste too much energy in heat, and get the light only as a sort of by-product.

"The luminous flame arc is almost twice as economical as the carbon arc, but has the bad habit of smoking incessantly, a condition which relegates it to open places only.

"The field is open for further advance, and this reminds me of an incident. A man called to see me a few days ago about a wave motor. My secretary told him I did not believe in them, and would not waste time in discussion. 'Good,' said he, 'I am greatly encouraged when such men leave wave motors alone—the field is open and I have the whole field.'"

The Public Lighting of Berlin and Paris.

In view of the controversy in New York some months ago over the price of public lighting, when the instances were cited of various European cities, the following figures from the British *Journal of Gas Lighting* as to Berlin and Paris, are of special interest. It will be seen that the statements made in these columns as to the greater cheapness of the arc light prices in New York were strictly true:

M. Lauriol, the chief engineer of the Public Lighting Office of the Municipality of Paris, and the chief of the "Direktion" of Public Lighting in Berlin, have forwarded the statistics referring to those cities on comparable lines to those which have been published in these articles for London. We will take the figures from Berlin first, as the lighting of that city has been so frequently the subject of allusion in writings and discussions on public lighting questions. The area of Berlin, our courteous correspondent informs us, is 15,235.3 acres. In all there are in the city streets 23,903 lamps; and of these only 576 are electric arc lamps and 112 electric incandescents. The incandescent gas lighting is of a diversified character; and what is more high-power and cluster lighting is far more prevalent there than it is in London. In Berlin there are a total of 23,215 incandescent gas lamps, of which 117 are high-power, fitted with two burners, and 31 similar lamps each supplied with only one burner. Cluster lighting bulks very largely; there being 6,071 lamps with two burners, 239 with three burners, and 8 with five burners. There are also 16,749 lamps fitted with single burners. The average cost of the arc lamps per annum is 424.92 marks, which (taking the mark at the approximate exchange of 20 marks to the pound) represent £21 4s. 11d.; the average cost of the electric incandescent lamps is 76.98 marks, representing £3 16s, 11¼d.; while the average cost of the incandescent gas lamps per burner (including maintenance) is 59.70 marks, or £2 19s. 8d.—the average consumption of gas being 18,435 cubic feet per annum.

In Paris we are dealing with a city of 3.02 square miles; and within its streets are to-day to be found 1,719 electric arc lamps, only 100 incandescent electric lamps, 49,294 incandescent gas lamps, and 2,552 flat-flame gas lamps. Intensive incandescent gas lighting greatly exceeds both London and Berlin; there being no less than 5,300 burners, each consuming from 5.3 to 9.5 cu. ft. of gas an hour. In 1,325 lamps, too, there are grouped clusters of two, three, four and five burners, with a total consumption of from 7 to 49.4 cu. ft. per cluster per hour. Of single incandescent burners, there are 42,669, consuming 3.5 cu. ft. of gas an hour. Against this considerable number, there are only 2,552 flat-flame lamps, burning from 3.5 cu. ft. to 8.5 cu. ft per hour Taking the whole of the incandescent burners, the average consumption would work out to 4 cu. ft. an hour; and similarly averaging the consumption of the flat-flame burners, it comes to 4.16 cu. ft. The average cost of the gas supplied to the incandescent burners is 65 frs. 81 c. (say £2 14s. 10d.), and the average cost for the flat-flame lighting is 66 frs. 37 c. Gas is charged for at the rate of 16 c. per cubic metre, which is equal to 3s. 5d. per 1,000 cu. ft. For the lighting, extinguishing, maintaining, and cleaning of the old flat-flame burners 6.5 c. per lamp per day is charged. For the incandescent burners there is an extra charge of 12 frs. per annum for the renewal of mantles, chimneys, additional work in cleaning, etc. The average cost of the electric arcs is 30 c. per lamp-hour, including maintenance, carbons, etc.

Power and Preservation of Niagara.

The American Civic Federation in its latest bulletin has the following with regard to the situation at Niagara, and the effect of power development on the beauty of the scene, quoted from the *Country Calendar*: "It may be that we ought to shut our eyes to the impending destruction of the glory of Niagara Falls. It may be that the hope of cheaper production of considerable quantity of electrical power, of breakfast foods, of chemicals, of utensils, is a more worthy object in our national life than the rescue of a noble and stupendous work of nature. To get at the exact situation, we have taken the facts recently presented by Dr. Clark, the New York State geologist, and other eminent special pleaders for Niagara, and we have had these facts verified by the expert hydraulic engineers most prominent in the work of installing the industrial plants that now threaten the Falls.

"The generally accepted volume of the Niagara River at the brink of the Falls is 224,000 cu. ft. per second. There are at present two power companies operating on the American side and three at work, or preparing for work, on the Canadian side. The process of using the power of the river produced by its sheer plunge of 161 ft., is to convey water by tunnels, canals or pipe lines from some point above the brink to the lower level below the Falls. It is obvious that if all the water were thus conveyed around the brink of subterranean passages or canals there would be none to make a Falls. But it seems that the American Horseshoe Falls will probably disappear when very much less than half the water is subtracted, for the brink of the hard dolomite rock over which the river plunges is no less than ten feet higher on the American side than on the Canadian, the greater bulk of the water passing on the British side of Goat Island. Dr. Clark estimates that when 40,000 cu. ft. of water per second has been subtracted from the river, there will be but a thin and pitiful apron of water remaining of the American Horseshoe Falls. He predicts that when 80,000 cu. ft. of water are used in the power plants, one may walk dryshod along the brink of these Falls and an arid waste of rockbed will be left between Goat Island and the mainland. These five companies now in operation are allowed by their charters to take 48,000 cu. ft. of water per second. So that there is clearly impending a contraction of the American Falls to a pitiful remnant. But the danger does not stop here. During the past winter and spring a sixth power company has been making the fiercest of efforts at Albany to renew an old charter which would allow it to take away a further quotum of Niagara Falls to be carried by canal across country to Lake Ontario. Dr. Clark estimates that this company would use not less than 10,000 cu. ft. of water per second, bringing the total to 58,400 cu. ft. Over and above this, the engineer of the commissioners of Queen Victoria Niagara Falls Park has suggested feasible sites for four additional Canadian companies, to consume 29,996 cu. ft. of water per second, bringing the total to 88.396 cu. ft. of water per second demanded by the work now going on, plus the contemplated operations. Finally, engineers point out that even if the power development is at once halted at the Falls, there is a strong probability that great quantities of water will be taken from the Great Lakes above the river, which would have the same deadly tendency to reduce the volume of water at Niagara Falls. With a difference in level between Lake Erie and Lake Ontario of 327 ft., and the distance between the two lakes only 27 miles, the engineering opportunity is obvious. Then there are the additional draughts of the Welland Canal, the Erie Canal, and the Chicago drainage canal."

Power in Arsenals.

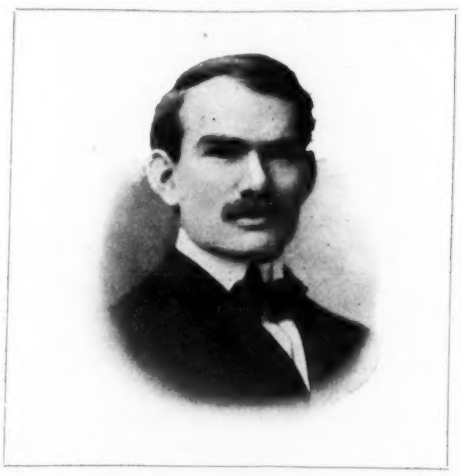
The Army Ordnance report, which has been recently issued, states with regard to the Watervliet Arsenal, Troy, N. Y., that the application of individual motors to the gun lathes in the north wing of the sea-coast gun shop has been completed and the results have more than fulfilled expectations. The output of the lathes has been increased, the control has been made more simple and the increase in efficiency has been considerable. A motor-generator set of 160 kw capacity has been installed, the Hudson River Electric Company furnishing the current. The service has thus far been very satisfactory. The extension of electric motor plant throughout the gun shop will be completed during 1906.

Electrical Engineers of the Times.—XLII.

DR. LEE DE FOREST.

Lee de Forest was born in 1873 at Council Bluffs, Iowa. His father, Henry S. de Forest, a Yale man of the class of 1857, and for a time tutor in the college, was a Congregational minister who had served as chaplain to the 11th Connecticut volunteers during the war between the North and the South. Mr. de Forest's early boyhood was spent in Alabama, where he received his primary education. After spending two years at Mt. Hermon School, Massachusetts, and graduating at the head of his class in 1893, he entered Yale University in the class of 1896 and was graduated from the Sheffield Scentific School with the degree of Ph. B. He then took three years of graduate work under Professors Wright and Gibbs, and in 1899 received the degree of doctor of philosophy. His thesis for the doctor's degree dealt wth the properties of electric waves propagated along two parallel wires. An account of this work was published in the *American Journal of Science* for July, 1899, under the title of "Reflection of Hertzian Waves at the Ends of Parallel Wires."

After taking his doctor's degree Dr. de Forest was employed in the telephone experimental laboratory of the Western Electric Company in Chicago, where he continued to experiment with Hertzian waves, especially on the electrolytic detector for use in wireless telegraphy. He was also at this time employed on the editorial staff of the *Western Electrician* in Chicago. In 1900 he and Edwin H. Smythe



DR. LEE DE FOREST.

filed an application for a patent upon an electrolytic detector of Hertzian waves, which in due time was granted. This patent is regarded by Dr. de Forest as basic, and as covering all electrolytic wireless telegraph detectors. Following this he developed a system of wireless telegraphy which differed radically from those theretofore used. In 1901 he demonstrated its successful working during the international yacht races, and in February, 1902, formed a company known as the De Forest Wireless Telegraph Company to put his system into commercial use. Among the most prominent characteristics of the De Forest system may be mentioned the use of the commercial alternating current as a source of power at the sending station, and the use of an electrolytic detector in combination with a telephone for receiving at the receiving station. In the fall of 1903 Dr. de Forest went to England and sent messages across the Irish Sea, demonstrating the successful operation of his system of wireless telegraphy to the satisfaction of representatives of the British Government. There are at present over 50 land stations and about 25 ocean steamships equipped with the De Forest system.

Dr. de Forest has taken out many patents in wireless telegraphy, the more important being on the electrolytic detector and a complete system of electrical tuning based upon the principles of the Lecher wires. He has contributed articles upon the subject of Hertzian waves and wireless telegraphy to this journal, the *American Journal of Science, Physikalische Zeitschrift*, the London *Electrician*, etc. In 1903 he read a paper by invitation before the Franklin Institute of Philadelphia upon "Electrolytic Wireless Telegraph Detectors," and at the International Electrical Congress at St. Louis in 1904, he presented another important paper upon the same subject. The Jury of Awards of the World's Fair at St. Louis in 1904, in addition to granting the de Forest system the grand prize and gold medal, awarded a diploma of honor and gold medal to Dr. de Forest for his work at the fair, especially in establishing wireless communication between St. Louis and Chicago.

Dr. de Forest is a member of the American Institute of Electrical Engineers, the New York Electrical Society and the National Geographical Society.

CURRENT NEWS AND NOTES.

NIAGARA POWER.—The Canadian Niagara Power Co. is seeking the privilege of carrying transmission cables across the Niagara River at Fort Erie into Buffalo.

PHILADELPHIA OFFICE.—The Philadelphia office of the ELECTRICAL WORLD AND ENGINEER, which for so many years has been located at 929 Chestnut Street (City Trust Building) will be removed on January 1 to the Real Estate Trust Building, Broad and Chestnut Streets.

INVERTED GAS BURNERS.—The advertising columns of gas journals are teeming with announcements of inverted gas burners and globes, accompanied in some cases by illustrations which at first sight might be taken for electric light brackets or electroliers. The gas burner is of the inverted or under-burning type, and the globes and fixtures are made to resemble closely those used with electric incandescent lights, a lesson apparently being taken from the exploitation of street gas "arcs" made to resemble as nearly as possible the electric arc lamp.

MOVING PLATFORMS.—Moving platform loops, with stations in different parts of Brooklyn, the system extending to the North River in Manhattan, were proposed to the New York Board of Estimate last week, as a solution of the bridge transit problem. After a hearing in which J. Edward Swanstrom, ex-Borough President of Brooklyn; Henry Sanger Snow of the Brooklyn League, Calvin Tomkins of the Municipal Art Society, and others opposed the transit and terminal plans of the Bridge Department, the board adjourned to the Governor's room in the City Hall, where the platform machine people showed kinetoscope views of their moving platform in operation. The board referred the entire terminal plan back to the bridge department with instructions to consider it in the light of the showing made by the moving platform advocates.

TELEPHONES IN CHURCHES.—The London *Chronicle* remarks with regard to a recent item in our columns: "It is not necessary to go across the Atlantic to the Presbyterian Church at East Orange, N. J., to find telephone receivers in the pews. They are to be found in 'The Scotch Church' in Regent Square, the church to which, in the days of Edward Irving, members of both Houses of Parliament flocked to learn the art of oratory. Only a few receivers have so far been placed in communication with the pulpit, but for the small cost of laying a wire any one may have a receiver in his pew. The 'dull of hearing,' who are not able to worship with comfort in their own church, might do worse than attend the Cathedral of Presbyterianism." This misses the point. Lots of churches have had the telephone installed, but at East Orange they were placed in the "way back" pews so as to put the occupants there on an equality with those in the front pews.

FEAR NIAGARA POWER.—According to up State newspapers, several small local gas and power plants in the western part of New York are afraid that the Niagara Power Company will put them out of business. State Gas and Electricity Commissioner John C. Davies stated that, while no formal complaints had been filed with the commission against the Niagara Power Company, several of the small local light and power companies had written to inquire whether the commission could not protect them against threatened aggressions by their larger rival. Officers of such companies in Medina and Palmyra, said Mr. Davies, have sent word that the Niagara Power Company is seeking to invade their territory and force them out of business by cheaper rates. They say that in so doing the Niagara company would exceed its charter rights. The commission intends to ask the advice of the Attorney-General.

PARIS-NICE TELEPHONE.—The French telephone administration announces that a direct telephone line from Paris to Nice will be inaugurated the coming season, in January probably. The total cost involved is 1,000,000 francs ($200,000).

ELECTRICITY AT KIMBERLEY, S. A.—We are advised by Mr. J. M. Bridge, chief clerk of the Electricity Department of the Borough of Kimberley, South Africa, that the council having entered into an agreement with the De Beers Consolidated Mines, Limited, for a supply of current in bulk, for the next twenty years, the municipal generating station will be closed down for that period. No plans are projected for subsequent work.

PURDUE UNIVERSITY.—About forty alumni of Purdue University living in or about New York met on Monday evening, December 18, and perfected the organization of the Purdue Alumni Association of the City of New York. P. E. Fansler, of J. G. White & Co., was elected president, and L. M. Grant, of the C. W. Hunt Company, secretary-treasurer. The association will meet on the second Wednesday of every month. The list of charter members numbers about 100.

WORK AT WORCESTER.—The Worcester (Mass.) Electric Light Company had, on December 17, a very effective full-page advertisement in the local *Telegram,* announcing the fact that that journal gets all its light and power from the company, and suggesting that others might well do the same thing in house, store or factory. The border of the "ad." is a "motif" of incandescent lamps and flexible cord, with the corners occupied by cuts of fan motors, power motors and arc lamps.

AMERICAN ELECTRICAL SALESMEN.—The first regular convention of the American Electrical Salesmen's Association will be held at the Grand Pacific Hotel, Chicago, Saturday, January 20. This is the first Saturday after the opening of the Chicago Electrical Show. This association was formed at a meeting of salesmen at the Illinois State Electric Association's Convention, held in Peoria, last October. Since then the membership has increased greatly. Mr. George H. Erich, Room 52, 88 Washington Street, Chicago, secretary, can furnish any further information desired about the association.

GASOLINE MOTOR CAR.—A Chicago dispatch states that a test was made on the Chicago & Alton Railroad on December 27 of a gasoline motor car which has been designed to meet electric railway competition. Between Chicago and St. Louis, the dispatch adds, it is proposed to build an electric railway parallel to the Alton tracks. The Alton company has determined to furnish between these points as good service as would be possible on an electric road. During the test runs the car, loaded to its capacity, attained a rate of forty miles an hour. It takes much less time in reaching full speed from a dead stop than the light trains drawn by steam engines. As a result of the tests the Alton will, it is stated, substitute gasoline motor cars for steam trains, which have been in the company's interurban service.

RAILWAY SIGNAL ASSOCIATION.—The next meeting of the Railway Signal Association will be held at the Grand Union Hotel, New York City, January 9, 1906, at which time the following papers will be presented: "Signaling on the East Bengal State Railway," by George K. Rogers, signal engineer. "The Care of Storage Battery as Used for Signaling Devices," by H. W. Lewis, supervisor of signals, L. V. R. R. "Preliminary Report of Installation and Maintenance of Storage Batteries," by I. S. Raymer, chairman, Committee No. 4. "Line Wire," by F. F. Fowle, special agent, American Telephone & Telegraph Co., New York City. Chairman Ames, of Committee No. 12, "Rubber Covered Wire," will take up for discussion the feasibility of a system for inspection of rubber covered wires. In addition to this an amendment of the Constitution and one to the by-laws is to be voted on.

ADVERTISING FOR POWER BUSINESS AT PORTLAND, ORE.—The Portland General Electric Company, of Portland, Ore., has reprinted for free distribution a paper read by F. G. Sykes before the electrical transmission section of the Pacific Coast Engineering Congress, held at the American Inn, at the Lewis & Clark Centennial Exposition, at Portland, Ore., June 29 and 30, 1905. In place of a preface are inserted a few words to manufacturers stating the advantages of electric power for manufacturing purposes. The article is a finely illustrated description of the large water power and steam plants, and sub-stations of the company. This article, although written originally for another purpose, is also well calculated to inspire the confidence of the power users, in the service given by the Portland General Electric Company. The company is furnishing 20,000 hp to the manufacturing establishments at Oregon City, where its largest water power stations are located, and over 15,000 hp in Portland, for lighting, manufacturing and operating street railways.

FRANKLIN IN FRANCE.—Mr. John Hay's "Franklin in France" article in the January *Century* says: "An interest which we can scarcely comprehend was taken in that day in natural science. Franklin was, by universal consent, the greatest natural philosopher of his time. He was hailed as the confidant of nature—the playmate of lightning, a Prometheus unpunished. The brightest constructive and critical energies of the best minds were devoted to the solution of political problems. And here, they said, was a man who had founded many states upon the principles of abstract justice, and had consolidated them at last into a superb model republic. For this hasty generalization had seized the foreign mind, always too apt to regard leaders instead of masses, and it was long before the millions of Americans got their due abroad. Thus it came that the great heart of liberal France went out at once in a quick rush of welcome to Franklin. He was the point that attracted the overcharged electricity of that vast and stormy mass of active thought. He became the talk of the town. They made songs about him. They published more than one hundred and fifty engravings of him, so that his fur cap and spectacles became as familiar as the face of the King on the louis d'or. The pit rose when he entered a theater. These are not trivial details. Those spontaneous honors, paid to an alien citizen by a people so long the victims of degrading tutelage, showed the progress they had made toward liberty. In honoring him they honored themselves. They vaguely felt he was fighting their battle. They read in his serene and noble countenance the promise of better times."

"SHE LIGHTS UP WELL."—M. Jules Huret, one of the leading French journalists, has just issued a very interesting book on his recent experiences in the United States. A large amount of space is given to New York, its hustle, bustle, noise, the electric cars on the bridge, the nightly scramble for the Brooklyn trolleys and the Jersey ferries—and much other unloveliness. But this is what he saw at night: "I was at the center of the river. There is no twilight in this country. Night falls immediately. Already the lights were shining on the New York side. For a long time I gazed at the rows which were lighting up as though by enchantment. Presently a magnificent sight spread itself out before my eyes. And this was the first sensation of true beauty that I had found in America, but so powerful and so grandiose! On my left the whole town is lit up. Night has suppressed the architecture; one sees no longer whether the houses are ugly or not. Only hundreds, thousands, one might say millions, of little squares of glass glitter from earth to sky. Scores of rows of lamps extend side by side until lost to sight. The very smallest houses, surpassed by the larger, themselves dominated by those higher still, give one the impression of a colossal perspective, like a giant climbing toward inaccessible heights. One has the vision of innumerable palaces en fête! Paris seen at night from the heights of Montmartre has nothing to compare with this! One would say that all the stars of the sky, more intense, had suddenly come to group themselves symmetrically 300 yards away. The colossal and the immeasurable arrive at beauty, a beauty which is titanic, crushing and splendid. And this profound impression of beauty which arises from the very number of these fires, from the mathematical order of their lines, imposes itself against every rule of æstheticism and art; it is force, incalculable energy, from which there is born a powerful and precious emotion. I remained stupefied with surprise and joy, and when I felt the cold which was piercing me I left with regret, sorry to abandon this new emotion which I was afraid of losing, as though it were a dream which awakening would chase away."

PLATINUM IN VERMONT.—According to a despatch from Burlington, Vt., a company has been formed there to work mines in Plymouth, whch are said to contain platinum in paying quantities.

LIGHTING THE STATUE OF LIBERTY.—A Washington despatch states that a bill is to be introduced in the House of Representatives providing an appropriation of $25,000 a year to light the Statue of Liberty in New York Harbor. The funds available for this purpose at present are only $3,500 a year.

RUSSIAN TELEGRAPHS.—The Russian telegraph strike continues to add its quota to the troubles in the Czar's dominions, and is the cause of immense inconvenience and loss, but appears to have been broken at some points. A special dispatch from Warsaw of December 25 says: "The strike of the post and telegraph employes here is at an end. The strikers have accepted the conditions of the Government. The telegraphers resumed work to-day. The railroad men to-day resolved to resume work unless their comrades in St. Petersburg should join the strike."

THE ENGINEERS' CLUB, of St. Louis, held its annual banquet at the Jefferson Hotel on the evening of December 20. The election of officers resulted as follows: President, W. A. Layman; vice-president, E. R. Fish; secretary, R. H. Fernal; treasurer, E. E. Wall. The speakers and their topics were: "The Engineer's Opinion of Himself," Robert Moore; "The Engineer in Print," William Marion Reedy; "The Engineer in Public Life," Andrew J. C. Reilly; "The Engineer in Trouble," Frederick W. Lehmann; "The Engineer and the Architect," William B. Ittner.

ELECTRIC MOTOR CONTROLLER.—Two patents granted December 19 to Mr. H. D. James have for their common object to provide a system of motor control that embodies separate protective means for the starting and the running positions, respectively. The circuit that is employed for carrying the starting currents to the motor is distinct from the path provided for the currents that normally operate the machine, so that the motor may be independently protected to suit the respective conditions. The controller is of the drum type. The drum is provided with an interlocking device which permits the progressive rotation of the drum in one direction and prevents rotation in the other direction. By means of this device the controller passes directly from the running position to the off position without passing through the starting positions.

STOPPING TRAINS.—According to *Railway & Locomotive Engineering*, Mr. J. A. Peabody, signal engineer of the Chicago & Northwestern Railway, has investigated the cost of stopping certain trains on the Chicago & Northwestern Railway and got others to make similar investigations on other western railroads. The cost of stopping a train of 530 tons, and returning it to a speed of 50 miles an hour, he found to be 42 cents. The cost of stopping a 2,000-ton train from 35 miles an hour he estimated to be one dollar. Another road estimated each stop of a six-car passenger train from 45 miles an hour to be 35 cents and for a 1,500-ton freight train from 15 miles per hour as 56 cents. The time lost for making a stop on a straight level track was estimated at 145 seconds. The aggregate of this extra cost for stopping trains is considerable and the possibility of saving this expense is worthy of more consideration than it has ever received. Many expensive investigations are made of things that have no money saving possibilities.

OIL LAMPS IN MAIL CARS.—The oil lamp seems to be a perpetual source of danger and trouble in these days, and it is certainly surprising that it finds a place for responsible service in situations where electricity is obviously superior to all other illuminating agents. The latest catastrophe is chronicled in press dispatches describing the explosion of an oil lamp in a United States mail car at Erie, Pa., where the car was set afire, the mail clerk slightly burned and a large amount of valuable mail matter destroyed. To anyone familiar with fire hazards it would seem that the interior of a swaying car is one of the last places in the world desirable for the use of an explosive illuminant, provided something better can be had. Aside from the fire risk, the flexibility of the electric light renders it unusually advantageous in mail car service, and the better distribution of light invariably results in greater speed and ease in deciphering addresses upon letters—a consideration of no small importance in the trying work of the railway postal clerk. It is to be hoped that such accidents as that at Erie will only serve to hasten the extension of electric train lighting into a field where it is so evidently sorely needed.

ELECTRIC TRACTION ON CANADIAN PACIFIC.—A move of considerable importance in connection with the motive department of the Canadian Pacific Railway is the decision of the management to take up actively the idea of using electricity as a motive power. For some time the officials of the electrical department have been working on the matter, and have investigated the experiences of other railways in that connection. It is understood that electricity will first be installed on some of the branch lines in the Province of Quebec, and a motor car for this purpose is now being constructed in the company's shops. If the trial trips with it are satisfactory, it is expected that electricity will be used for nearly all the company's suburban and branch lines. In a recent interview, Sir Thomas Shaughnessy, president of the Canadian Pacific Railway, stated that the company intends adopting electricity for some of its shorter branch lines, and, casting his eye into the future, he foresaw the day when electricity would take the trains from coast to coast. He pointed at the same time to the extraordinary advantages that Canada possesses in her unrivaled waterfalls, which could be used for the development of electric power all the way from the Atlantic Ocean to the Pacific.

LAYING FOUNDATION STONE.—The foundation stone of the new building of the Engineers' Club, on West Fortieth Street, New York City, opposite Bryant Park and the new Public Library, was laid on December 23, at 2.30, by Mrs. Andrew Carnegie, whose husband declared the task well and truly done. The ceremony was quite informal, but the club was well represented by its officers and committees, including President W. H. Fletcher and Past President John C. Kafer. The architects, Messrs. Whitfield & King, were also present. Fortunately the weather cleared during the afternoon, and thus the party were enabled to inspect the building, now up to the ninth story in the steel work and to the third in marble and brick casing. The records deposited in the stone included a Bible of 1905, a club book of 1905, copies of the *Herald, Tribune, Sun* and *Times* of December 23; a copy of the certificate of incorporation; a booklet of the old clubhouse at 374 Fifth Avenue; a half dollar, quarter dollar, dime, nickel and one cent; a card of W. L. Crow, the builder; a copy of Mr. Carnegie's letter of gift to the Engineering Societies and the Engineers' Club; a chronological history of the club; a list of members elected since the publication of the club book this year; a list of the incorporators of the club; the programme of competition for the selection of architects for the two buildings; and floor plans of the new house.

CROWDED TROLLEY CARS.—Advices from Cleveland, Ohio, state that the new health code, which will probably become a law by the first of the year, will contain regulations governing the sanitary condition of street cars, including the question of the number of passengers that shall be carried on each. A resolution presented to the health board for adoption into the code recites that an unsanitary condition is created by the overcrowding of cars, creating a dangerous menace to health through the lack of ventilation by such overcrowding, and suggests six rules governing the subject. These rules are: "No street car operated within the city limits shall at any time have on board, as passengers inside the car, more persons than can be seated upon all the seats of said car and half as many again standing in the aisle or aisles thereof. The foregoing regulation shall not apply to persons standing upon the rear platform of such car. The company or companies owning or operating street cars in the city of Cleveland shall put in a conspicuous place in each car the number of persons permitted therein, in conformity with this regulation, and take such measures as shall be necessary to enforce the regulation hereby established, and each car containing more than the number of persons herein allowed shall constitute a violation of this regulation. The conductor of each street car shall enforce the regulation hereby made and the failure on the part of any such conductor to so enforce this regulation shall constitute a violation by him and he shall be, on conviction, subject to the penalties provided by the revised statutes."

SUBMARINE TRANSMISSION AT FT. SMITH, ARK.—The Ft. Smith (Arkansas) Light & Traction Co., which is controlled by H. M. Byllesby & Co., of Chicago, has purchased the electric lighting plant at Van Buren across the river from Ft. Smith. The present lighting station in Van Buren will be abandoned and the load will be carried by a 6,600-volt transmission line from the railway and light station in Ft. Smith. This will necessitate a 6,600-volt, two-phase submarine cable 2,500 ft. long under the river.

CONSTANT-CURRENT SYNCHRONOUS CONVERTER.—In order to provide a system by means of which the load upon a synchronous converter which delivers power to a storage battery and supply mains may be maintained approximately constant within a large working range regardless of the variations in the load upon the direct-current circuits, Messrs. B. G. Lamme, C. F. Scott and F. Conrad, according to a patent issued December 19, would place a constant-current regulator in the alternating-current supply leads, and would use a booster in the direct-current delivery circuits.

PUBLIC GOOD WILL.—These pages contained recently two articles relative to the campaign of education carried on by the gas company in Chicago and commending the work to the attention of electric light companies. The Iowa Electrical Association has reprinted these in circular form and sent them to all the local lighting companies in the State. Mr. G. S. Carson, the secretary of the association, in forwarding us copies, says: "The question of State legislation, controlling all public service corporations, is sure to come, and it is the writer's opinion that the companies had best welcome it with good grace and live up to the laws. It will place the control of the business in the hands of competent commissioners, instead of the aldermen of each town attempting to judge of a business of which they know practically nothing, or else attempting to use the corporation as a means to further their own political aspirations."

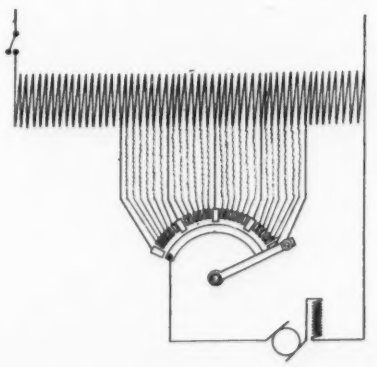
CHRISTMAS GREETINGS.—Admiral Dewey's greeting to the officers and men of the navy, bespeaking a united stand for the good of the country and the service, was communicated on Christmas Day to the officers and men aboard the vessels throughout the world wherever they could be reached by telegraph. To the men along the Atlantic Coast there was also sent a Christmas greeting by means of wireless telegraphy, which served as an elaborate and practical test of this auxiliary of the naval service. The wireless messages went by direction of Admiral Manney, Chief of the Bureau of Equipment. They were dispatched from the wireless station at the Washington Navy Yard, and were relayed from place to place. Early responses came from the officers nearest Washington, and before midnight of Christmas Day many of the stations had replied, including New Orleans, Colon and San Juan, the Colon reply coming by way of Guantanamo. The test was satisfactory to Admiral Manney.

GERMAN PATENTS.—The Boston *Pilot*, commenting on a recent matter in these pages, says: "The latest number of THE ELECTRICAL WORLD AND ENGINEER contains a sensible article on the status of American inventions in Germany. Dr. Alfred Muller, a solicitor for foreign patents in New York City, has taken pains to examine into this subject with a view to finding out whether the frequent complaints of American inventors, with regard to the difficulty of obtaining patents in Germany, were well founded. The conclusion reached is that American inventors are largely responsible for their own difficulties. They imagine that procedure in Germany with regard to obtaining patents should be identical with that in the United States. This, of course, is an entirely erroneous view. Germany has her own methods, which she must insist upon. Reference is made to the report of Consul-General Frank F. Mason, in Vol. LXVII of Consular Reports. With all respect to the weighty authority of these gentlemen, we cannot help feeling that the German Government does not fail to take advantage of her procedure to the detriment of foreign, especially American, inventors. But we are not entirely sure that we have very just ground of complaint, when we consider the fact that American competition is a very dangerous matter in the German business world."

A BOON TO SHIPPING.—It is stated from Washington, D. C., that demonstration of the practical worth of wireless telegraphy has been the object sought by Rear Admiral Manney, of the Bureau of Equipment, ever since the time the charge of the wireless work of the government was concentrated in his office. Principally this work has been along the line of making the system which now extends on the Atlantic coast from northernmost Maine to Key West and then jump across to Guantanamo, to Culebra and Colon on the isthmus, a practical means of communication just as accurate and reliable as would be a system of land wires and ocean cables. A secondary matter, and a very important one in the view of the bureau, is the work done by wireless telegraph in the way of saving life and property at sea. In order to definitely ascertain the present value of the wireless stations of the navy in this matter, Rear Admiral Manney recently sent a request to the wireless station at Newport, R. I., Commander Albert Gleaves in charge, asking for a report. In reply nine recent instances of information were reported, and commenting upon this record, Commander Gleaves writes: "This shows what a tremendous factor wireless telegraphy is destined to become in ameliorating and, in many cases, altogether averting disasters on the high seas."

CENTRAL STATION DATA.—The *Live Wire*, issued by the Wesco Company, of St. Louis, has the following excellent suggestion: "Our attention has been called to what we consider an excellent plan adopted by some central stations. On their letter heads these lighting companies have printed data concerning their plants that will be very useful to supply houses in filling orders. The most useful information is in answer to these questions: Is the system direct or alternating current? What voltage (give both primary and secondary if alternating)? Phase and cycles? Is there a day circuit? What incandescent lamp base is used? As most letters written by central stations are concerning purchases it will be seen readily how this information would aid the supply house in filling an order. Facts which the station man might fail to state in his letter, because so familiar to him, would be told by his printed letter head, and in very many cases would save the purchaser the time and annoyance of making an explanation by mail or telegraph. If all central stations would adopt this plan, it seems to us it would be of mutual advantage to the purchaser and his supply house." This information is given in our "Central Station List" for some 4,000 plants, revised every six months, but it would certainly be a great convenience if it were carried on the "letter-heads" or on enclosure slips. This is even more desirable as to foreign central stations.

POTENTIAL CONTROL FOR ALTERNATING-CURRENT MOTORS.—One of the greatest difficulties encountered in the use of variable voltage in controlling the speed of alternating-current motors resides in the fact that either the individual coils of the transformer will be short-circuited or the motor circuits will be opened when passing from one voltage to another. A scheme disclosed by Mr. Giorgio Finzi, of Milan, Italy, in a patent issued December 19, is shown in the accompanying illustration. Between the five main contact pieces connected directly to the auto-transformer, there are inserted six other auxiliary keys also connected



with the intermediate points of the winding through suitable resistances in such a manner that the brush will invariably remain in contact with two keys. Mechanical devices are provided so that the brush is not able to remain on one of the auxiliary keys, but is carried rapidly to the main keys. It is possible, therefore, to proceed from one working voltage to the next without interrupting the main circuit or providing short-circuit currents, and without entailing any considerable heat loss in the resistances.

CABLEMEN STARVE.—The difficulties of maintaining remote cable stations in mid-ocean are illustrated in the following special dispatch from Victoria, B. C., of December 24: "The steamer *Miowera,* which arrived yesterday from Australia, reports that when she arrived at Fanning Island the cable staff were without provisions and were living on cocoanuts."

TELEPHONE NEWS SERVICE.—Mr. James F. Land, general manager of the Michigan State Telephone Company, plans to establish a system in Detroit, with an independent circuit, over which will be supplied at the touch of a key sermons, baseball returns, theatrical programmes, concerts, weather reports, stock quotations and news bulletins. Already Mr. Land is conducting a service with a few acquaintances as subscribers, to experiment with the scheme before organizing a company to lay wires and establish a complete system with the best copper wire circuit, transmitters and receivers.

CONDUITS AT SYRACUSE.—The Central New York Telephone Company has proposed that the city of Syracuse pass an ordinance requiring the Central and a new competitor to put their wires in conduits in a large part of the city. It would cost the old company about $200,000 for its share of the work. This plan appears to meet with popular approval. The franchise of the new company provides that it shall place its wires in subways, but the common council, urged by the mayor, has rescinded an ordinance requiring the new company to live up to the terms of the franchise, and has passed an ordinance in favor of poles to be located by the commissioner of public works.

BIRMINGHAM (ALA.) TELEPHONY.—The growth of telephony has been such at the southern iron center, Birmingham, Ala., that the Southern Bell Telephone Company finds it necessary to put down at once 36 miles of cable, 200 and 100 pair, to connect up its main and suburban exchanges. It is said that the telephone system in Birmingham covers a greater territory than that of any city in the country of four times the size. Atlanta's system is not nearly as large, although Atlanta is much larger in population. Richmond is supposed to be twice the size of Birmingham in population, but its system covers about one-fourth the territory covered by the local exchange. There are over 6,000 telephones connected with the Birmingham exchange through the main exchange and the suburban exchanges.

GOVERNMENT SERVICE.—The following is from *Harper's Weekly,* but really contains nothing new to those who have used the service: "The telephone system of Paris leaves considerable to be desired, and meets with constant complaint on the part of the subscribers. One of the latter endeavored to test the speed of the various means of communication of the city, sending messages in different ways from his rooms in the Rue Richelieu, in the center of the city, to a friend on the Avenue de la Grande Armee near the Bois de Boulogne. He found that a bicycle messenger made the trip in 11 minutes and 15 seconds, as compared with 23 minutes for a cab. A message sent via the metropolitan railway required 31 minutes, by omnibus 34 minutes, a telegram 35 minutes, a message by the pneumatic tube 3 hours, while the message sent by telephone did not arrive at all."

WIRELESS NEWS SERVICE.—A special cable dispatch from London of December 23 says: "The use of wireless telegraphy in the transmission of news has recently been the subject of consideration by some of the newspaper owners in England, and at least one syndicate is contemplating the adoption of the system. Mr. Cuthbert Hall, managing director of the Marconi Telegraph Company, said to a *Daily Express* representative: 'We have been approached by a number of newspapers in the north of England with the suggestion of forming an agency for the transmission of news to them by wireless telegraphy from London. We could erect a high power station here, from which we could send messages to any part of the country, and they would be received simultaneously in different towns. We can work to any distance over land. We sent messages from England over Europe to the *Renown* when she was taking the Prince of Wales to India and was within 100 miles of Port Said.'"

PROVINCIAL BOSTON.—Mr. Frederick P. Fish, president of the American Telephone & Telegraph Company, after the stockholders had ratified, at a special meeting, an issue of $150,000,000 of convertible bonds, took occasion to say: "Our company's condition is satisfactory," said Mr. Fish, "and better than it has ever been before, but one thing which I do not like is that it is a matter of common gossip that we are a Boston concern. Boston and New England, much as I dislike to say it, are in a way provincial and not able to handle with entire satisfaction big enterprises which require large sums of money and which need a broad market for the securities." Mr. Fish's remarks attracted much attention and provoked discussion among the New England stockholders who had come to New York to attend the meeting. It was pointed out that in the early days of railroad building Boston and New England capital had built many of the great roads of the West, which are now controlled in New York. The truth from the financial standpoint seems to be generally admitted, although Boston is to-day one of the wealthiest cities in the world.

PROVIDENCE LIGHTING PLANT.—The report of the committee on lights of the Providence City Council recommends a contract with the Narragansett Electric Lighting Company. The report makes an elaborate analysis of municipal figures in New England and elsewhere, and insists very strongly that the data show it to be advisable to stay out of the municipal plant business. The contract accompanying the report provides for the carrying out of the agreement with the electric lighting company for street lights at a reduction of $4.75 per light per year, beginning January 1, 1906; the maintenance of the 1,908 arc and 2,185 incandescent lights now furnished, in addition to such others as may be ordered, from the date of the contract to June 15, 1912, at 2,000 cp and 32 cp, respectively; the erection and maintenance of poles, wires, conduits and appliances for the same; the burning of all lights all night and every night, except as otherwise provided, and the making of a rebate for failure therein; the maintenance of conduits by the company in any street wherein it has or may have the right to erect poles and wires, upon filing a plan with the commissioner of public works, and the erection of poles and wires in any street where there are no conduits. The price of lights is fixed as follows: Arc, to burn all night and every night, 28.7 cents per night from January 1, 1906, to June 15, 1909, and 27.4 cents for the succeeding three years, ending June 15, 1912. Arc lights extinguished at midnight, 55 per cent of above prices. Incandescent lights to burn all night and every night, $24 per year, as at present, to June 15, 1912. Incandescent lights extinguished at midnight, 55 per cent of this price. The company agrees during the term of the contract to allow the city 75 per cent discount from current rates on all incandescent lights furnished the city for any other purpose than under the provisions of the contract.

ACTIVITY IN HARTFORD.—The following "local item" from Hartford, Conn., is rather amusing: "The rivalry between the Hartford Electric Light Company and the Hartford City Gas Light Company for business sometimes leads to amusing situations. Since the agitation began for an ordinance permitting electrical signs of various sizes and dimensions extending from the fronts of business buildings, the gas company has got busy and is now installing a large number of Welsbach arc lamps in front of store windows, more or less over the street line in many places, the service being rendered for the price of the gas consumed. They brighten the street and make the sidewalks as well as the fronts of the stores quite brilliant. This week several employes of the gas company made preparations to light the front of the stores in the Linden Building by that method under agreement with occupants of the stores. Pipe was cut and fitted and bent to fit the conformation of the building, and it was the intention of the gas company to have the lights in operation to-day or to-morrow. Somebody, however, forgot that the building was owned by the secretary of the Hartford Electric Light Company and just when things were apparently reaching consummation, Custis C. Cook interposed with a veto. Being the owner of the building, he had the right to say what should be attached to it and he did. The result is that the operations of the gas company on that building have been discontinued and the Hartford Electric Light Company is about to install outside electric lights. They will be of the Nernst pattern and the service is guaranteed to the occupants of the stores to be as cheap as gas would have been In addition, not to indicate that he owns the building or to show that he lives there, Mr. Cook has arranged to light up the tower of the building, so that the Linden will be a blaze of light at night hereafter."

A 10,000-Volt Transmission System Without Transformers.

IN a paper presented by Mr. W. H. Patchell before the British Institution of Electrical Engineers on December 7, 1905, much interesting information was given concerning the equipment of the Bow generating station of the Charing Cross Company of London. The generators of this station are designed to deliver 10,000 volts directly without transformers. The power from the generators is transmitted by way of underground cables to the various substations, main transformers have been eliminated, the 10,000-volt current being fed directly to motors which are direct connected to direct-current generators.

The power house contains a boiler room 75 ft. wide, with two rows of boilers facing each other; and an engine room parallel to the boiler room, also 75 ft. wide, with 36.5 ft. clear under the traveling crane. The boilers are of two types, horizontal and vertical, each equipped with its own superheater.

A novelty was introduced in the case of the larger horizontal boilers, where a grate was arranged in the ordinary way at the front and another at right angles to it, which could be fired from the side. These second grates have proved to be of enormous benefit when sudden fog or a thunderstorm has called for an extra supply of steam at very short notice. The ashpits for the two grates are quite separate, and are provided with the usual doors. At times of light load the boilers are fired from the front only, and the doors in connection with the side grates are all closed. A little dust falls on the bars at the back which are not otherwise protected, but do not suffer from the high temperature to which they are exposed. As soon as the demand arises coal is thrown on to the side grates, the ashpit doors opened, and the extra fires are got under way with surprising rapidity. The large heating surface in proportion to the grate worked at light loads is an advantage, and the large size of boiler adopted gives much less radiating surface per square foot of heating surface than in the small sizes usually adopted.

The boilers of the upright type are arranged in pairs, each operated as a single steam unit. The author stated his belief that they form the largest steam-producing unit in existence. A single pair of upright boilers has been steamed at the rate of 100,000 pounds per hour, so that it can easily supply steam to a 4,000-kw generating set.

The type of setting to be adopted was very carefully considered. Owing to the difficulties likely to be experienced, due to the expansion of such large walls in brickwork, it was felt that even if they could be kept upright they would not be air-tight; a modification of the wrought-iron casing used for marine boilers was therefore adopted. The brickwork between the grates, which is honeycombed and carried up about 6 ft., becomes incandescent during working, and its effect, combined with the ample combustion chamber, ensures a much more perfect combustion than is obtained in the horizontal type of boiler. Coal which might give heavy smoke when burned under the horizontal boilers can, with no more care taken in the hand-firing, be burned without smoke in the "upright" boilers.

The water supply is derived from two 13-in. Artesian wells on the premises, 400 ft. deep, each of which yields 15,000 to 20,000 gallons per hour as required. The method of pumping adopted is the air-lift system, and the water raised is discharged into a large reservoir in the basement below the pump-room. From this reservoir the water is pumped by slow-speed compound steam Woodeson pumps to a tank at the top of the building, from which it runs back by gravity through the water-heaters at the various engines to a tank over the pumps into which their exhaust steam is discharged and to which all the feed-pump suction-pipes are connected. There are also alternative suction pipes direct into the reservoir in the basement.

FIG. 2.—INTERIOR VIEW OF BOW STATION.

The electric generating equipment consists of two 800-kw sets, four 1,600-kw sets and two 4,000-kw sets. The engines driving the 800-kw generators are three-cylinder, triple-expansion, high-speed, enclosed engines of Messrs. Belliss & Morcom's type. They exhaust into jet condensers in the basement, the air and circulating pumps for which are driven by electric motors.

The engines driving the 1,600-kw generators are horizontal cross-compound engines by Messrs. Sulzer Bros., of Winterthur. In details they differ materially from the usual type of slow-speed engine, inasmuch as the connecting rods and cranks are enclosed, and the oil supply is continuous and under pressure.

The valves are of Messrs. Sulzer's latest four-seated pattern.

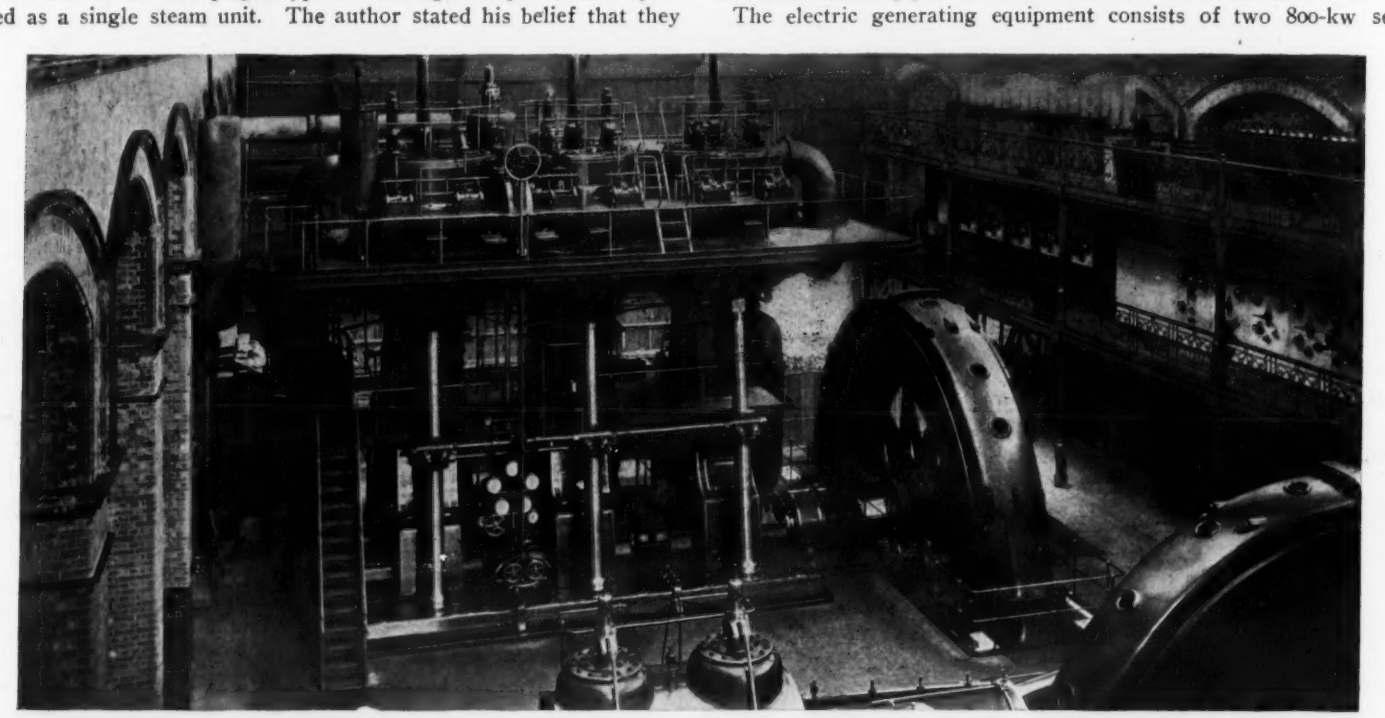


FIG. 1.—VIEW OF INTERIOR OF BOW STATION, SHOWING VERTICAL SETS.

The pistons are provided with tail-rods, and are supported outside the cylinders by special bearings. The cranks are set at 108 degrees instead of the more usual 90 degrees, with the low-pressure crank leading. The exhaust steam from the low-pressure cylinder is divided in an oil separator and taken to two jet condensers, one on each side of the engine. These condensers stand on their air-pumps, which are driven from the high and low-pressure crank pins respectively.

The engines driving the 4,000-kw generators are vertical three-cylinder compound, with the high-pressure cylinder in the center

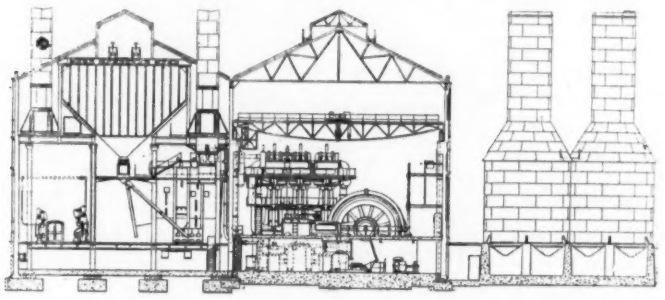


FIG. 3.—CROSS-SECTION OF BOW GENERATING STATION.

and a low-pressure on each side of it driving on to cranks which are equally divided. By this arrangement excessive weight or dimensions of any of the parts is avoided, and an even turning moment is obtained.

The principal interest in connection with the three-phase, 10,000-volt generators naturally resides in the insulation employed. The armature winding is in mica tubes embedded in slots which are nearly closed. Crossings of the wire are as far as possible avoided, and where the coils leave the iron core they are carefully wound over templates and covered over with insulating tape to prevent breakdown between adjacent coils or between coils and the frames. The coils are further protected from accidental contact by a strong perforated cover, which also enhances the appearance of the machine. If some of the theories which have been advanced in connection with the discovery of nitric acid in high-tension machines are correct, evidences of such acid might reasonably be expected in these machines, and it is interesting to note that even careful dissection and examination has revealed no signs of it.

The switchboard is at one side of the generator room. It is arranged in two distinct halves, which, however, may be connected by an emergency switch. The generating plant is numbered con-

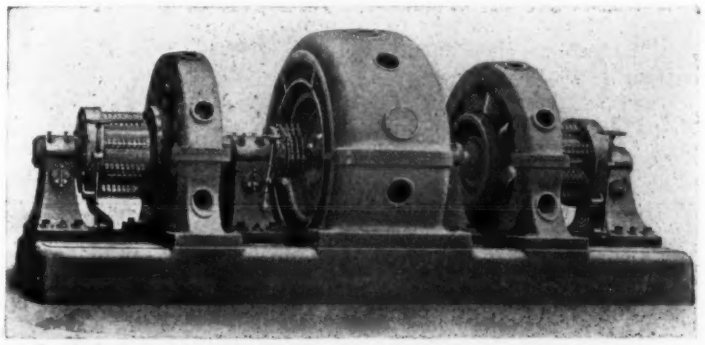


FIG. 4.—LAHMEYER'S INDUCTION MOTOR-GENERATOR.

secutively, each of the odd numbers being connected to one half of the switchboard, and the even numbers to the other half. The switchboard is practically a three-decker. The rheostats for the field circuits of the machines stand on the main engine-room floor underneath the principal switchboard gallery. The panels carrying the controlling gear are upon the principal gallery. The high-tension switches are placed on the upper gallery, and are worked positively from the principal gallery by levers.

Ten trunk feeder mains at present leave the generating station; they are three-core, paper insulated, lead-sheathed cables, The cables are laid on the solid system in steel troughs, which are heavily bonded to comply with the Board of Trade requirements.

There are four sub-stations in the City, each provided with motor-generators, and a storage battery. A striking feature of the sub-stations resides in the fact that no stationary transformers or rotary converters are used. The author stated in this connection that the small size of a rotary converter as compared with a motor generator is very striking and seems much in its favor; but it must be remembered that the necessary transformers are, like the condensers for turbo-generators, generally out of sight in a large basement, and the mind, if not the eye, must grasp them both together. After investigating the various types of rotaries and considering the respective merits of synchronous and induction motors for the particular case, the choice fell upon synchronous motors for the majority of the machines with one or two induction motor sets in each sub-station. In all cases the motors are wound for the full pressure of 10,000 volts, with a uniform size of motor of 500 hp and a speed of 300 r.p.m.

Induction motors are preferred in some quarters because they can be started up more quickly, and it is believed that in the event of an accident they will maintain their load better than synchronous machines, which, however, are preferred by some engineers because of their better power factor. The regulation of the direct-current side can be managed equally well with either type of machine under normal conditions. Each motor-generator has its own standard panel complete. Main switches, ammeters, voltmeters, also field switches and ammeters, are provided for both the motors and generators. A synchronizing gear of voltmeter and lamps combined is provided for the synchronous motors, and the motor field switches are omitted on the panels for induction machines. The synchronous motors are all started up from the generator side, and the starting switch is used as the main switch for one pole of the generator,

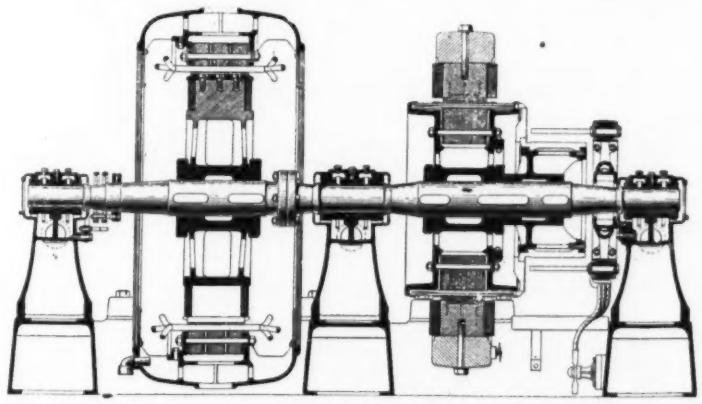


FIG. 5.—LAHMEYER SYNCHRONOUS MOTOR-GENERATOR.

while the induction motors can be started alternatively from the generator side or from the motor side, and are fitted accordingly.

Extreme solidity of construction was called for and heavy insulation to ensure freedom from interruptions either mechanical or electrical. The results have so far quite realized the highest expectations. The motors in some cases drive 350-kw generators wound for the full pressure, 400 to 440 volts, across the "outer" wires, and in some cases they drive two generators each of 175-kw capacity, which are wound for 200 to 220 volts, and are used as balancers on the three-wire system.

Practically no movement of the brushes is required from no load to full load of 1,200 amp. The latest construction is even better, as in it the generator machines are provided with compensation poles, and can be run from full load in one direction to no load, and up to full load in the other direction, without moving the brushes or showing any signs of sparking.

For regulating the pressure delivered by the batteries when the generators are disconnected and for governing the flow of current into them when the generators are in operation, reversible boosters are used. The pressure from the "outers" of the network is used for running the booster motors. The regulation is done manually and no automatic devices are installed. The most prominent feature of the supply network is the use of 2×220 volts in the three-wire lighting circuits instead of 2×110 volts as formerly employed and as corresponds to the practice in America.

On account of the fact that the 10,000-volt cables possess considerable electrostatic capacity it was found that under working conditions in the event of a circuit being opened through, for instance, the action of a fuse, a surge was likely to occur, and that it would be safer to provide spark-gaps. A spark-gap in itself, although a safety-valve for a surge, may start a rush of current which will cause further surges. The use of spark-gaps as a remedy may easily be worse than the disease, it is therefore very important to

carefully consider the amount and form of resistance to be used in series with them. The common form of horn type spark-gap was experimented with and abandoned in favor of a spark-gap of the type which has carbon on the one side and copper on the other. The traveling of the spark up the parallel portion of the horns is increased by the chimney action of a glass enclosure, and the result of many tests has been to show that they may be calibrated and set with much greater accuracy than the ordinary bent-wire horn type. As regards resistances, a non-inductive type must of course be used, and after many experiments an extended trial was given in the form of liquid resistance which consists of earthenware vessels filled with a solution of glycerine and water. What at first appeared to be unaccountable changes took place in some of the resistances; investigation showed that they were due to the action of sodium or other salt in the air. Alternative solutions have also been tried with sodium in them which were found to be more constant. Further experiments have been made and are still being made in the direction of dry resistances, as no matter how good it may be a liquid resistance always has the disadvantage that it is liquid and may leak.

The width of spark-gap employed is 4.5 mm. for 10,000 volts

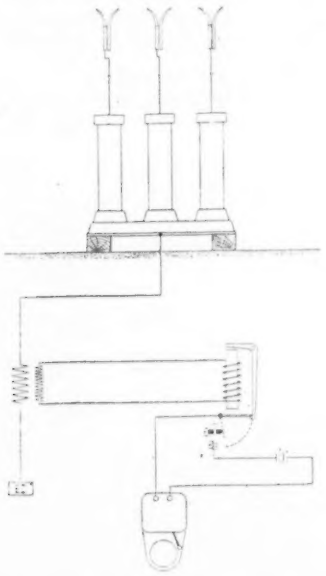


FIG. 6.—DIAGRAM OF SPARK-GAP DISCHARGE DETECTOR.

working pressure, i. e., 5,800 volts between each phase and earth with the center of the star earthed. A spark will jump the gap at 12,000 volts when the horns are clean and the atmosphere normal.

Occasional and irregular working of the spark-gaps soon attracted attention. For the purpose of determining the causes a detector was installed with the gap, as shown in Fig. 6. The apparatus consists of a small transformer with its primary inserted in the earth wire of the spark-gap resistance, without adding appreciable self-induction to the circuit, and a relay which is actuated by the secondary and rings a bell. When a discharge occurs, the relay shutter falls, causes the bell to ring, and so calls the attention of the switchboard attendant, who notes on a report form the exact time, and whether any change in switching or alteration in the conditions of running was made. These reports are then collected and examined with the running logs of the other stations, when frequently the effect in one place can be directly traced to the cause in the same or other place. But again there are many occasions when no cause can be assigned.

Irregularities when starting up machines, although not sufficient to affect easy synchronising or switching in, are prolific causes of spark discharges. Experiments showed that it was dangerous to connect a cable directly to the high-potential circuits, and that the safer procedure was to switch it in at a low voltage and then raise the pressure.

A so-called "charging gear" is provided in the shape of a small motor-generator and two transformers with suitable connections, so that it may either be used to run up the pressure of the cables to working value or to test them at 15,000 volts. A three-phase generator is driven by a direct-current motor, and produces current at a normal 2,000 volts pressure. This pressure is then stepped up by a bank of two three-phase oil-transformers, and is varied by varying the field of the 2,000-volt generator. Special bus-bars and switches are provided in connection with the charging gear, so that a cable may be put in parallel with other working cables, or a working cable may be taken off the main bars and discharged for testing or other purposes.

Municipal Ownership vs. Private Ownership.

BY R. S. HALE.

Theoretical discussions of whether one-cent street fares with an average cost of two cents per mile, as in Glasgow, or five-cent fares with an average charge of one cent per mile, as in Boston, are better, are of theoretical interest. The final test, however, of municipal and private ownership, as of all problems of government, is the happiness of the people and the best test of the happiness of the people in a particular locality is whether the people prefer to go to that locality to live, i. e., whether the population is increasing, or, on the other hand, whether the people that live there go somewhere else, so that the population decreases.

We have all heard of the fox who lost his tail, and the glowing accounts of the advantages of municipal ownership in Australia and New Zealand as compared with the rapacity of private corporations in the United States are rather dimmed when we note that Australasia is, if anything, losing in population while millions of immigrants come every year to the United States.

In England a statistical investigation was made a short time ago in which the increase of population of the large cities between 1896 and 1901 was compared with the amount of municipal trading done by these towns. The result may be most easily stated by dividing these various cities into four classes:

First, we have the class of cities that did very little trading, as shown by the amount of their debt that was incurred for trading purposes. Taking first the towns that had a trading debt between nothing and 50 per cent of their ratable value, we find eleven such towns where the average increase in population was 19 per cent.

Next, taking the towns that did a little more municipal trading, but not so very much more, we find six towns where the investment in municipal trading was between 50 and 100 per cent of their annual value and the increase in population of these towns was 14 per cent.

Taking next the towns that did rather more trading, whose investment was between 100 and 200 per cent, we find 19 such towns whose average increase in population was 15 per cent.

Taking next the towns that did a great deal of trading, whose investment in trading ventures was over 200 per cent of their annual value, we find 22 such towns and these towns had an average gain in population of only 10 per cent.

The smallest gain in population of any of the 11 towns that did very little trading was greater than the average gain of all the 22 towns that did a great deal of trading. Only two out of the 22 towns that did a great deal of trading gained as much in population as the average of the towns that did but very little trading.

Undoubtedly the advocates of municipal ownership will say that English experience is not trustworthy, and will point with pride to the progress made in the United States in the towns that have gone in for municipal ownership. For instance, Richmond, Alexandria, Wheeling, Bellefontaine, Charlotteville, Hamilton, Duluth, Wakefield and Holyoke are, by means of their municipal gas plants, giving such good service to their citizens, that the people who live in New York, Boston, Chicago, etc., etc. are fleeing from the rapacity of the private gas companies in the metropolis to live in these cities.

The check in the growth of Philadelphia and the way in which it is losing in position as a leader of American cities since it gave up the control of its gas works to a private corporation is very marked. When the Philadelphia gas plant was run from City Hall, Philadelphia never needed reform. But now, under private ownership, they have had to elect a reform administration.

There cannot be the slightest doubt that it is the private ownership of their gas, electric light, street railway and other public utilities that has destroyed the chance of New York, Brooklyn, Chicago, San Francisco, St. Louis, Baltimore and Boston's becoming in the future the leading cities of the United States, any more than there is any doubt that the municipal ownership of their gas and electric plants will make Taunton, Holyoke, Dunkirk, Jacksonville, South Norwalk, Allegheny, Alameda, Austin, Logansport, Peru and the other 815 towns, villages and cities that do trade in electricity and gas the centers of population in the future.

Long Distance Power Transmission by Direct Current.

BY FRANK J. SPRAGUE.

THE views reported as having been expressed at the meeting of the British Association at Johannesberg by an eminent English scientist, the installation and successful operation of two high-potential constant direct-current power transmission systems in France and Switzerland, the 60-kilovolt proposal for Lyons, and the announcement of a project to transmit power from Zambesi to the Rand, a distance of 700 miles, also by direct current, are announcements which naturally arrest attention, because counter to conclusions reached by the majority of electrical engineers, including myself, and generally of late considered as beyond debate.

I will not at the moment express any special opinion as to the commercial character or technical possibilities of the Zambesi project —which seem at first glance most doubtful—nor to discuss the pros and cons of an alternating-current and direct-current transmission at high potentials, the former because of its simplicity and great flexibility having peculiar and great advantages hard to offset; but it may prove of theoretical interest to call attention to some plans I proposed some years ago, certainly at that time novel, before the alternating-current system had come into vogue, and to discuss the potential requirements of long-distance transmissions on a special plan of direct-current operation.

In a paper read before the Franklin Institute of Philadelphia in 1889, the substance of which was repeated at the Cornell University two years later, I advocated an automatic system of direct-current power transmission, using single machines at moderate potentials, and batteries of machines in series with each other at each end when the demands of the transmission required an increase of potential beyond the limits of practical construction for a single machine. I will quote at length from that paper as follows:

"The transmission to one point from another, with a single generator and a single motor with variable loads, presents two solutions. The first is the use of the compound dynamo and differential motor; but a far more interesting solution is the use of two series machines which, when properly proportioned, become perfectly self-regulating. I will briefly touch upon the theory of this method of transmission. We have the condition that the same current passes through each field and armature, and also the condition that the speed is constant, while the work is variable. Since work may be expressed as a product of speed and torque, and since the speed is constant, it follows that the motor torque must vary directly as the work. Again, we have as an expression for the work done the product $e\,C$. Since the speed of the motor is constant, e must vary directly as the strength of the field, which, where the magnetization is low, will vary directly as the current, and when more highly magnetized in a much less degree. E being the e.m.f. of the generator and K the resistance of the circuit, we have:

$$C = \frac{E - e}{K},$$

and, as already stated,

E varies as e, as $E - e$, and as C,

and the work

varies as $e\,C$, as C^2, as e^2, and as E^2.

The dynamo likewise being driven at a constant speed, E likewise varies as the strength of its field. If m equals the number of turns of wire in the dynamo field, and n those in the motor field, then the ampere turns or magnetizing forces are expressed by $m\,C$ and $n\,C$. It follows from what proceeds that the magnetizations due to $m\,C$ and $n\,C$ should vary in the same proportion; in other words, the characteristics of the generator and the motor must be similar between the limits of the variation in load. The electrical efficiency of the circuit being

$$\frac{e}{E},$$

we have the following fact: that the electrical efficiency is a constant for all loads within the limit of automatic regulation. If the machines are of the same general type, then when correctly proportioned the ratio of their weights and watt capacities should be the same as the electrical efficiencies of the circuit."

"As a modification of the proceeding, especially where large powers, long distances and necessarily high potentials are used, it is advisable to divide the generators and motors into a battery of machines of identically the same weight and character, the number of the machines being the ratio of the electrical efficiencies, the generators all to be driven from the same line of shafting, and the motors to drive on to a common line, and the current to pass through all the machines in series."

To take care of the high potentials on the pole line I indicated what seemed to me an advisable practice as follows:

"We can only accomplish this [practically perfect insulation] by the most careful line erection and choice of insulators. It can be materially aided by running the positive and negative leads each on an independent line of poles, and perfectly clear of all trees."

"When a double line of poles is used it is advisable to wrap the lower ends with bare wire for a distance of about six feet above the ground, and to connect these bases together; or, if the poles are close together, a galvanized-iron or copper wire should be taken around each pole at the distance given and joined together. This is to avoid the possibility of a serious shock in wet weather, which might be received by a person leaning against a wet pole if any accident should occur to the line insulators when very high potentials are used."

In such a system the drop on the line, the e.m.f's of the generator and motor, and the current vary alike as the square root of the work done, and inasmuch as on a large system the variation of work is progressive, the automatic changes in current necessary to get constant speed regulation would not introduce any special electrical troubles on the line.

Assuming that such power transmissions would very likely be from a water source, and bearing in mind the necessity, from a commercial standpoint, of keeping first cost at a minimum under any given condition of unit cost of materials and efficiencies, I developed a number of equations which established certain curious facts bearing upon a minimum first cost of installation. These seem particularly pertinent in considering some of the potential possibilities of an equipment similar in distance to that under consideration. To illustrate them I will abstract from my papers as follows:

Let l = distance in feet between the generating and receiving station, plus the sag.
E = e.m.f. at motor terminals.
v = volts fall on line, $E + v$ being the e.m.f. at the terminals of the generator.
e = e.m.f. of motor and E' that of the generator.
α and β = the commercial efficiencies of the motor and generator, and λ that of the line.
$c\,m$ = circular mils of the conductor.

Then for any horse-power, n, we have

$$C = \frac{746\,n}{E\,a}.$$

Allowing m ohms as the resistance per mil-foot of copper, the total line resistance would be

$$\frac{2\,m\,l}{c\,m}$$

for a complete metallic circuit. Hence the drop or fall of potential on the line

$$v = \frac{746\,n}{E\,a} \times \frac{2\,m\,l}{c\,m} = \frac{1{,}492\,n\,m\,l}{E\,a\,c\,m},$$

or

$$c\,m = \frac{1{,}492\,n\,m\,l}{E\,v\,a}.$$

In a transmission system the cost of installation may be divided into four parts, the generating plant complete, the conductors, the poles, insulators and line erection, and the motors, general expenses being apportioned. We may assume the leakage as practically nil, and the cost of motors a constant per unit capacity within the potential limits considered.

With any given motor potential, the greater the loss on the line the less the cost of the conductors, but the greater the cost of the generators. On the other hand, the less the loss on the line, the greater its cost, but the less the cost of the generators. It follows,

then, that the least cost to the contractor is determined when the variation in the cost of the generating plant is equal to that in the cost of the line.

We have the formula:

$$C M = \frac{1{,}492\, n\, m\, l}{E\, v\, a}.$$

If d = weight of one mil-foot of copper, the weight per foot of the copper of conductor would be

$$\frac{1{,}492\, n\, m\, l\, d}{E\, v\, a}, \tag{3}$$

and the total weight for $2\,l$

$$\frac{2{,}984\, n\, m\, l^2\, d}{E\, v\, a}. \tag{4}$$

If b is the cost in cents per pound of copper (including freight and handling), we have for the cost of the wire in the line

$$\frac{2{,}984\, n\, m\, l^2\, d\, b}{E\, v\, a}. \tag{5}$$

Evidently $\frac{e}{E'}$

is the ratio of the capacities of the motor and generator,

$$\frac{n}{a}$$

the horse-power of electrical energy delivered to the motor terminals,

$$\frac{E+v}{E} \times \frac{n}{a}$$

that delivered to the line, and

$$\frac{E+v}{E} \times \frac{n}{a} \times \frac{l}{\beta}$$

that delivered to the generator.

I make use of the terms horse-power and commercial efficiency, for it is partly from the commercial aspect I wish to look at the problem.

Let us further make K equal the cost in cents per horse-power of the generating plant complete. Then its cost would be

$$\frac{E+v}{E\, a\, \beta}\, n K. \tag{6}$$

If M is the cost of motor per horse-power developed, similarly erected in place, the cost of the receiving plant would be $n\,M$.

One element is somewhat indeterminate, and is dependent chiefly upon distance and local conditions, the cost of poles, insulators and line erection, and we will call this P.

Summing up we have the general expressions for the cost per horse-power delivered:

$$C = \frac{E+v}{E\, a\, \beta} K + \frac{2{,}984\, m\, l^2\, d\, b}{E\, v\, a} + \frac{P}{n} + M \tag{7}$$

It is evident that this is variable, and since the costs of the motor and the poles, insulators and line erection are arbitrary, save for the increase in cost of insulation as potential increases, which may be ignored here on the score that the best would be used, the variation is narrowed down to the cost of the generating plant and the material in the line. It is here apparent, as already pointed out, that if we diminish the cost of the line by increasing the fall of potential, we must at the same time increase the cost of the generating plant, and on the other hand, that if the loss on the line is reduced, its cost will increase, while that of the generating plant will diminish.

Differentiating with C and v as the variables, we have

$$\frac{d\,C}{d\,v} = \frac{K}{E\, a\, \beta} - \frac{2{,}984\, m\, l^2\, d\, b}{E\, a\, v^2}, \tag{8}$$

or equating to zero,

$$\frac{K}{\beta} = \frac{2{,}984\, m\, l^2\, d\, b}{v^2}, \tag{9}$$

which is the condition of least cost.

From (9) we have

$$v = 54.6\, l \sqrt{\frac{m\, d\, b\, \beta}{K}} \tag{10}$$

That is, *with fixed conditions of unit cost of generators and copper and efficiency of generators, the number of volts fall on the line to get the minimum cost of plant is a function of the distance alone, and is independent of the electromotive force used at the motor,* a somewhat interesting conclusion.

Substituting the equivalent value given by equation (9) in (7) we now have for the equation of least cost:

$$C = \frac{E+v}{E\, a\, \beta} K + \frac{v}{E\, a\, \beta} K + \frac{P}{n} + M, \tag{11}$$

the first element representing the cost of the generating plant and the second the cost of the wire, per horse-power developed by the motor. From this equation we have the relation:

$$\frac{\textit{Cost of wire}}{\textit{Cost of generating plant}} = \frac{v}{E+v}. \tag{12}$$

This is not, however, in the most useful form, and since the commercial efficiency is that with which we are concerned, we will introduce its term, λ.

We have for the horse-power delivered to the generator:

$$\frac{E+v}{E\, a\, \beta}\, n,$$

and n that taken out of the motor; hence we have

$$\lambda = \frac{E\, a\, \beta}{E+v}, \tag{13}$$

or,

$$v = \frac{a\beta - \lambda}{\lambda} E. \tag{14}$$

Substituting the value of v in equation (11), we have a new form for the cost equation as follows:

$$C = \frac{K}{\lambda} + \frac{a\beta - \lambda}{a\, \beta\, \lambda} K + \frac{P}{n} + M, \tag{15}$$

which may also be written

$$C = \frac{2\, a\, \beta - \lambda}{a\, \beta\, \lambda} K + \frac{P}{n} + M, \tag{16}$$

and

$$C = \frac{2K}{\lambda} - \frac{K}{a\, \beta} + \frac{P}{n} + M, \tag{17}$$

We also have the relation:

$$\frac{\textit{Cost of generating plant}}{\textit{Cost of wire}} = \frac{a\, \beta}{a\beta - \lambda}. \tag{18}$$

That is, *with any fixed couple and commercial efficiency, the cost of the wire bears a definite ratio to the cost of the generating plant, and this is so no matter what the unit cost of materials.*

Referring to equation (10) and substituting for m its approximate value, 10.5, and for d its value, .00000302705, we have:

$$v = .308\, l \sqrt{\frac{b\, \beta}{K}} \tag{19}$$

Combining this with (13), we have

$$E = \frac{.308\, l\, \lambda}{a\beta - \lambda} \sqrt{\frac{b\, \beta}{K}} \tag{20}$$

We now see what influence the cost of copper has when the commercial efficiency is maintained constant, which is, to vary alike the value of v and E as it increases, as the square root of such increase. It will be noticed also that a variation in K inversely affects E and v, likewise as the square root.

It follows from the above that if we do not limit ourselves in the e.m.f. used, the cost per horse-power delivered, exclusive of poles, insulation and line erection, is with given unit costs of materials, for least total cost and for a given commercial efficiency, independent of the distance.

In order to get a practical idea of what conditions would exist on a long line, we may substitute some permissible numerical values. These of course vary largely with conditions, but are sufficiently near possibilities to be fairly illustrative.

For this purpose let α and β each = 95 per cent, b = 20 cents, K = $100, and M = $25. Substituting in equation (19) we have:

$$v = .308\, l \sqrt{\frac{20 \times .95}{10{,}000}} = .0134288\, l,$$

irrespective of what is the motor potential or the commercial efficiency. We also have for any commercial efficiency:

$$E = \frac{\lambda}{\alpha\beta - \lambda} v = \frac{\lambda}{.9025 - \lambda} l,$$

whence we have for say three assumed efficiencies,

λ = 50 per cent, E = .016682 l
60 .026635 l
70 ..046421 l

Taking the distance from Victoria Falls to the Rand, 700 miles, and adding 5 per cent for sag and necessary detours, l becomes 3,880,800 ft. Substituting this, we will have the following results:

With λ =	50 *p.c.*	60 *p.c.*	70 *p.c.*
Drop on line would be.....	52,114	52,114	52,114
E.m.f. at motor terminals....	64,740	103,365	180,151
E.m.f. at generator terminals.	116,854	155,479	232,265

which figures are rather startling, and illustrate how serious is the problem, especially in attempting at such distances commercial efficiencies above 50 per cent, 20 per cent increase actually doubling the generator potential. Suppose the unit cost of K is lowered, say, to $60 instead of $100; then v and e will be increased $\sqrt{\frac{100}{60}} = 1.29$ times—if we maintain the condition of minimum cost of installation—and we have another comparative table as follows:

When λ =	50 *p.c.*	60 *p.c.*	70 *p.c.*
Drop on line would be.....	67,227	67,227	67,227
E.m.f. at motor terminals....	83,515	133,302	232,395
E.m.f. at generator terminals.	150,742	200,529	299,622

These potentials are of course for the full load. For all loads lower than this, e, E and C are reduced equally as the square root of the power delivered.

It is interesting to note that when λ = 50 per cent, the currents are 242 and 188 amperes, and the conductors of 304,637 and 183,457 mils, respectively.

Of course with alternating currents the pressures would run very much higher, and all the problems are much more difficult of determination.

We may now proceed to get costs for the three efficiencies assumed. Substituting in the equation

$$C = \frac{2K}{\lambda} - \frac{K}{\alpha\beta} + \frac{P}{n} + M,$$

we have, for $\alpha\beta$ = .9025, when

$$\left.\begin{array}{ll} \lambda = 50 \text{ per cent}, & C = 2.892\, K \\ 60 & 2.225\, K \\ 70 & 1.749\, K \end{array}\right\} \quad K + \frac{P}{n} + M$$

If K = $100 and M = $25, then with

$$\left.\begin{array}{ll} \lambda = 50 \text{ per cent}, & C = \$314.20 \\ 60 & 247.50 \\ 70 & 199.90 \end{array}\right\} + \frac{P}{n}$$

For comparison, let K = $60—all other things being unchanged. Then with

$$\left.\begin{array}{ll} \lambda = 50 \text{ per cent}, & C = 198.52 \\ 60 & 158.50 \\ 70 & 129.94 \end{array}\right\} + \frac{P}{n}$$

An inspection of the cost equations shows how important the question of the amount of power to be transmitted becomes when the distance is considerable. Up to the point when the poles and insulators must be increased, the greater the amount of power the less of course the total cost per horse-power delivered. A convenient method is to determine the amount of power rated per mile of line to get the increment to be added to the cost of installation per horse-power.

Taking the Zambesi project, and assuming 20,000 hp delivered, this would be 28.57 hp per mile of route. With, for example, $1,000 as the cost per mile of poles, insulators and erection, the cost per horse-power would be $35.

With the $100 unit the total costs per horse-power delivered would then be for

λ = 50 per cent....$349.20
60 .... 282.50
70 .... 234.90

and with a $60 unit cost for

λ = 50 per cent....$233.52
60 .... 193.50
70 .... 164.94

But can full advantage be taken of the reduction of cost due to lower unit costs?

Taking any particular potential as the maximum limit on the line, it will be noted that as the cost per unit of the generating equipment decreases, and likewise the total cost at any particular commercial efficiency, one cannot in practice work at the same commercial efficiency with differing power unit costs and under the conditions of total minimum cost of installation.

By comparing the potential tables for K at $100 and $60 it will be seen that the maximum line potentials are about at a parity, say, 150,000 volts, at 59 per cent commercial efficiency for the former and only 50 per cent for the latter.

A practical comparison of costs, then, as determined by this maximum line potential, would, for example, in this particular case, be: $288.18 for the former, against $233.52 for the latter.

This is but one of the many questions which arise, for in any long-distance transmission problem a compromise determination must be made which is based upon many co-related elements; and the best selection is one of considerable difficulty.

Among the practical questions which will very properly arise is one something like this:

Admitting a certain maximum possible potential at the motor end, may it not be advisable to cut down the line loss to keep down the maximum potential on it and at the generating station, and also to meet a possible water shortage.

A single comparison is instructive: With λ = 50 per cent and K = $100, we have E = 64,740 volts and v = 52,114.

Let us, for example, double the amount of copper, but assuming that the poles and insulators remain unchanged; then the drop of potential at full load will be 26,057 volts and $E + v$ = 90,797 volts, instead of 116,854.

The distribution of power will be as follows:

First case.	H.P.	*Second case.*
2.0000	to generators	1.5540
1.9000	to line	1.4763
.8474	loss on line	.4237
1.0526	to motors	1.0526
1.000	out of motor	1.0000

Referring to the cost equation,

$$C = \frac{K}{\lambda} + \frac{\alpha\beta - \lambda}{\alpha\beta - \lambda} K + \frac{P}{n} + M,$$

we find for the two conditions costs as follows:

C = $200 + 89.20 + 35 + 25 = $349.20
C' = 155.4 + 178.40 + 35 + 25 = 393.80

Excess in second case.....$44.60

or $892,000 on a plant to deliver 20,000 hp under the specific conditions given.

Referring now to the general problem, the graphic representation of the relation of E, l and λ under the conditions of minimum first cost of installation is a simple matter.

For the assumed values of α, β, K and b we have the equation

$$E = \frac{.0134288\ \lambda}{.9025 - \lambda}\ l$$

Let us lay off on the axis of x the distance in feet, and on the axis of y the e.m.f. at the motor terminals.

Then for any given value of λ the ratio of

$$\frac{E}{l}$$

is fixed, whatever the actual value, and we can draw the efficiency lines $O\,A$, $O\,B$, etc., for

$$\lambda = 70 \text{ per cent, } 60 \text{ per cent, etc.,}$$

which will, with the different values of l and E, give us the required information. This, however, is not in a general form, and so we will find an intersecting efficiency line. By an inspection of the diagram we see that a line can be drawn which will intersect the specific efficiency lines at such an angle that the intersected portions are proportional to the differences of efficiencies. To effect this the differential of E/λ must be a constant.

Referring to a preceding equation, and transferring, we have

$$\frac{E}{\lambda} = \frac{E + .0134288\ l}{.9025}$$

If the members of this equation are made equal to a constant, then differentiating the second member for E and l we have

$$\frac{d\,E}{d\,l} = -\ .0134288$$

which determines the intersecting efficiency line laid off with reference to E and l. To find the intersections let $d\,E = 50{,}000$. Then $d\,l = 3{,}723{,}341$ ft., or 705+ miles.

The limiting efficiencies are 0 and .9025 per cent, which should be laid off as indicated. A chart so prepared need consist only of the axes of x and y, on which the motor terminal e.m.f's, and the distances are laid off, together with the intersecting efficiency line, and it is then ready for reference, giving at a glance the graphic solution of the basic elements of this kind of a transmission under the condition of minimum total first cost, and with known efficiencies and unit costs of generating equipment and conductor. A line for determining the value of v may of course be added.

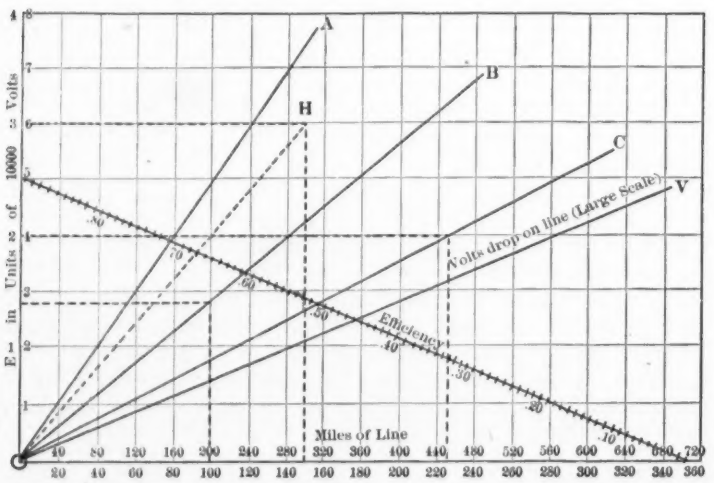


CHART TO DETERMINE ELEMENTS OF LONG DISTANCE DIRECT-CURRENT TRANSMISSION FOR MINIMUM FIRST COST UNDER SPECIFIC CONDITIONS.

In engraving, the lines A, B and C were not accurately drawn to pass through the exact points of intersection with the efficiency line, namely, .70, .60 and .50.

To illustrate the use of such a diagram, suppose we wish, under these assumed conditions, to transmit a distance of 100 miles at a commercial efficiency of 60 per cent, what would be the required e.m.f. at the motor terminals? Drawing the efficiency line $O\,B$ till it meets the ordinate erected at 100, we find the e.m.f. to be about 14,000 volts, and the drop on the line about 7,100 volts. On the other hand, suppose we are limited to 40,000 volts at the motor, and must have an efficiency of 50 per cent, what would be the limiting distance? Reversing the above process, we find it to be 456 miles. Suppose, again, that we must operate at a distance of 150 miles, and can work up to an e.m.f. of 30,000 volts at the motor, what would be the efficiency? Through the intersection of the proper e.m.f. and distance lines, we draw the efficiency line $O\,H$, and at its intersection find the efficiency to be about 67½ per cent.

In conclusion, a common sense way of looking at the technical possibilities of a general project of power transmission on the lines indicated is this:

Assuming the largest unit and highest single machine potential practical to have been determined, it follows that if we wish to extend transmission beyond the economical limits dictated by this initial potential, and likewise to increase the amount of power delivered, then if the machines are well insulated from ground and from each other, like increases of capacity and potential, together with like increase of distance, can, with unchanged current and cost per unit of power delivered, be safely attained by simply coupling the machines in series to get potential and capacity, and paralleling the series, connected or not to independent lines, to get additional capacity. The generators, although all connected up in series, may by proper power be independently driven instead of being physically coupled together, but the groups of motors at the receiving station should either be physically connected together, or if there is local power distribution through other machines, they may be independent, and drive local generators connected to a common electrical load.

On such a plan the transmission of a large power at high potential over long distances by a direct current of equally variable pressure and volume cannot be dismissed as entirely visionary. On the contrary, its possibilities may merit careful study and consideration in some cases.

High-Frequency Currents.

In a recent Cantor lecture Prof. J. A. Fleming showed some interesting experiments relating to the measurement of high-frequency currents and electric waves and illustrating resonance phenomenon. The latter phenomenon was made clear to the audience by the mechanical analogy of two pendulums hung side by side from a piece of stretched cord. If the two pendulums were of the same length, the swinging of one aused the other to swing also, but if the pendulums had different periodicities, there was no such inter-action. By placing the pendulums nearer together, or further apart, the time taken for the movement of one to be communicated to the other could be reduced or increased, and this corresponded, in wireless telegraphy, to a strong and weak coupling. The lecturer's cymometer was then explained, and an actual experiment was carried out, in the course of which it was found that there were two oscillations of quite different frequency in the circuit tested. This, the lecturer explained, was the case with every wireless telegraph transmitter. The current flowing in the cymometer circuit varies constantly as the handle of the instrument is shifted from one extreme position to the other, and this change in current can be readily traced by inserting a thermo-junction in the cymometer circuit and connecting it to a galvanometer.

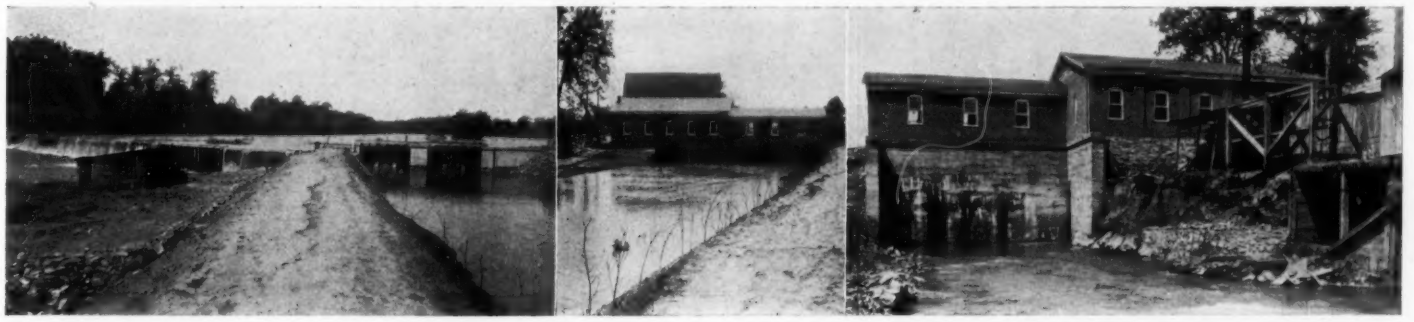
In addition to measuring frequency, the cymometer could be used for the speedy determination of capacity and inductance, and the methods of such measurements were experimentally shown. It was very often thought that the wave length was four times the height of the transmitting air-wire, but it has been found by actual measurement that it approximated more nearly five times the length of the antenna. A very neat illustration of the fact that high-frequency currents occurred on the surface of conductors only, and did not penetrate into the metal, was obtained by measuring successively the oscillation constants of three similar squares of copper, iron and galvanized iron wire respectively. The readings were practically identical in the first and third cases, but in the second case no reading could be obtained because of the magnetizing effect of the iron through which the high-frequency currents had necessarily to pass. Hence galvanized iron wire can well be used as a cheap substitute for copper, but iron wire should not be employed. As a last example of the many-sidedness of the cymometer, it was mentioned that the instrument could be used for calculating the decrement of electric waves.

Hydro-Electric Lighting and Power Plant at Harrisonburg, Virginia.

BY F. F. COLEMAN.

NEAR the town of Harrisonburg, in the Shenandoah Valley of Virginia, there has recently been placed in operation a well designed hydro-electric lighting and power plant which furnishes a good example of the possibilities which lie in the development of the numerous small waterfalls which are to be found throughout the country. The hydro-electric equipment belongs entirely to the municipality. The plant is located on the south fork of the Shenandoah River, 12.5 miles from Harrisonburg. The site was purchased, plans were prepared, contracts were let, and the installation completed and placed in operation all within a year's time.

The dam is located one-fourth of a mile above the plant, where a solid limestone ledge runs entirely across the river. This feature



FIGS. 1, 2 AND 3.—VIEWS OF HYDRAULIC DEVELOPMENTS, SHOWING DAM, CANAL AND TAIL RACE, HARRISONBURG.

is exceptional, for the geology of this section indicates that the limestone breaks off on the west of the river with quartzite, the typical formation of the Blue Ridge, on the east. The ledge is fairly horizontal, forming a most secure and excellent foundation for a dam.

The dam is 720 ft. long and 15 ft. high to the crest of the spillway, or "river section," which is built of timber on crib work securely bolted to the solid rock with 192 1.25-in. bolts from 3 to 5 ft. long, then loaded with loose stone placed inside of the cribs. The design is such that it may be replaced by a concrete dam without stopping the plant, the present timber-work acting as a coffer dam. The effective fall is 20 ft. The concrete abutments are 20 ft. high, extending 5 ft. above the spillway. They are 488 ft. apart, affording passage for a considerable flood without overflowing the concrete abutments or race banks.

The western abutment contains six large regulation gates, intended to prevent too much water from entering the race during freshets and overstepping the embankments. The head race is one-fourth of a mile long, about 100 ft. wide, and 15 ft. deep.

The power house is divided into two parts; the generator room, 45 by 52 ft., containing all of the electrical machinery, and the wheel room, 20 by 42 ft. The floor line is 32 ft. above the bottom of the wheel pits and 5 ft. above high water mark of the river.

The wheel room extends across the head race and rests on the solid concrete masonry walls which form the sides and ends of the wheel pits. The end wall is 6 ft. thick at the bottom, 4.5 ft. thick at the top, and is 32 ft. high. It is pierced by three arched openings, each 8 ft. wide and 9 ft. high, through which the water escapes after leaving the wheels. The intake is protected by a wrought-iron rack 13 ft. high and 40 ft. long. Within this are the service gates, which are operated from within the power house.

The power house itself is one story in height and is built of brick. There are three wheel pits. Each measures 12 ft. square. They are divided one from the other by concrete masonry walls 2.5 ft. thick.

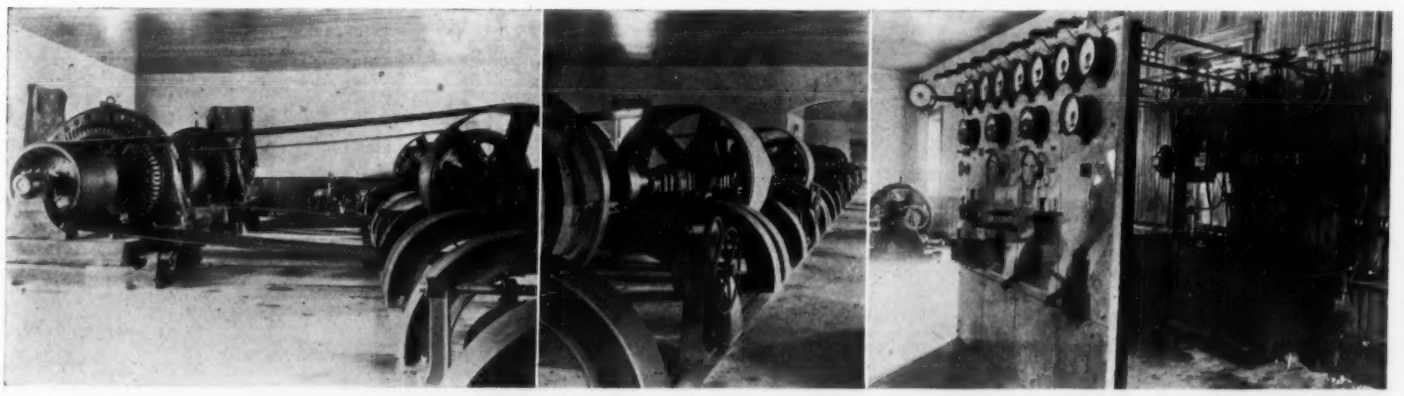
The power is developed by three 50-in. vertical turbines rated at 450 hp each, and a 20-in. turbine of 72 hp. The three larger turbines are connected with a horizontal main shaft which drives the generators by means of belts. The connection to the main shaft is through a bevel mortise gear, with wheels 7 ft. in diameter and 15 in. face. The pinions on the main shaft have 48-in. friction clutch hubs which permits of each turbine being operated or shut down independently of the others. The main shaft is 6 in. in diameter and 85 ft. long, and operates at 280 r.p.m.

Two pulleys each 70 in. in diameter and 38-in. face are provided to drive the generators. The pulleys have 6-ft. quills, and each is equipped with a 48-in. friction clutch to throw it in or out of use as may be desired.

The 20-in. turbine is direct-connected to the exciter generator. In addition to operating the generators, the hydraulic plant furnishes mechanical power for operating the Rockingham mill, situated somewhat more than 100 ft. away, by means of a rope drive placed under the floor of the power house.

A Woodward horizontal speed governor is connected to the gate mechanism of each turbine by means of flexible wire cables.

The electrical equipment of the power house includes two 250-kw alternating-current Bullock type generators, a 20-kw direct-current generator to act as an exciter to the main generators, and a four-panel switchboard. The two large generators are driven by belts from the main shaft at a speed of 450 r.p.m., producing a three-phase current of 60 cycles at 11,500 volts.



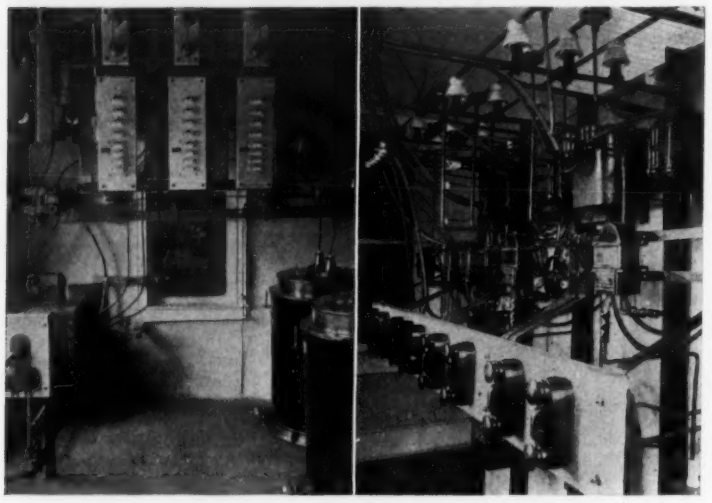
FIGS. 4, 5 AND 6.—VIEWS OF INTERIOR OF GENERATING STATION, SHOWING GENERATORS, COUNTER-SHAFT AND SWITCHBOARD.

The exciter runs at 700 r.p.m. and produces current at 120 volts. Although the exciter is direct-connected to the 72-hp turbine wheel, provision is also made to run it by a belt from the main shaft in case of any accident to the small wheel.

The switchboard, which was furnished by the Allis-Chalmers Company, is made of blue Vermont marble, and is provided with all standard instruments of the best character. It consists of four panels, each two inches in thickness. There are two generator panels, one exciter panel, and one feeder panel. All the wiring is open, the low-voltage wires being lead-covered, while those for the high-voltage are covered with 30,000-volt rubber insulation and car-

ried on Locke insulators spaced 7 in. apart. An adequate lightning arrester is mounted at the end of the generator room, where the transmission wires leave the building. The transmission lines are carried out of the building through 6-in. tile pipe that is set through the wall, sloping downward at an angle of 35 degrees.

The current leaves the power house at a tension of 11,500 volts and is transmitted a distance of 12.5 miles to the sub-station over three strands of No. 4 bare, hard-drawn copper wire. The line follows generally the public roads. The wires are carried by chestnut



FIGS. 7 AND 8.—VIEWS OF INTERIOR OF SUB-STATION.

poles from 35 to 40 ft. in length, set five feet into the ground at distances of 125 ft. apart. Each pole is provided with cross-arms for transmission wires and a short cross-arm below on which telephone wires are placed. Provision has been made for the wires for two transmission lines, but only one set has been put up.

The top arm carries two pins and the next lower arm four pins. The wires now in use are placed on the top pins of the upper arm and one of the pins nearest to the pole on the lower arm. They are spaced 27 in. apart in the form of an equilateral triangle. Double arms and guys are used at all turns and curves. The line is pro-

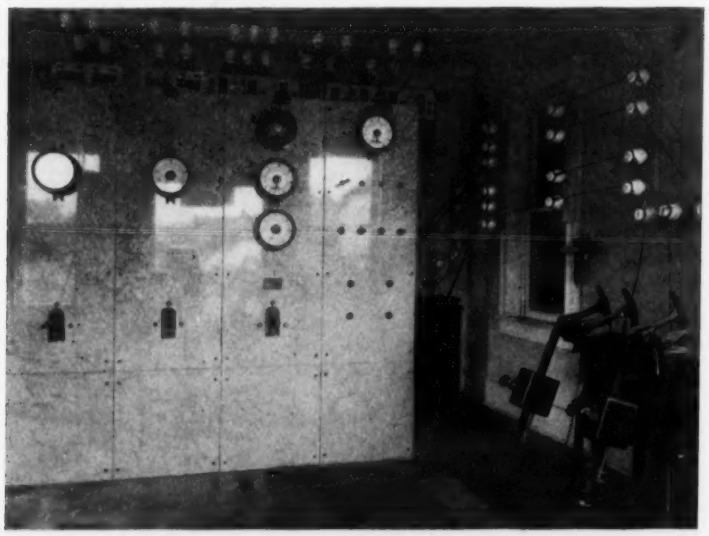


FIG. 9.—SWITCHBOARD AND CONSTANT-CURRENT TRANSFORMERS IN SUB-STATION.

tected from lightning by means of a barbed iron wire run along the tops of the poles and grounded at every fifth pole.

The sub-station is a brick building containing two transformer rooms each 12 by 14 ft., a switchboard room 16 by 18 ft. and a store room 18 by 20 ft. The transformer rooms have concrete floors.

The equipment at the sub-station includes one high-voltage automatic compartment switch, provided with a small switchpanel, three 100-kw, self-cooling, oil-filled Bullock transformers, wound for 11,000 to 2,200 volts, connected in delta, and a four-panel switchboard with lightning arresters of the same style as those used at the power house.

The sub-station switchboard is also of blue Vermont marble, two inches thick, and consists of two lightning feeder panels with watt-hour meters, one three-phase power feeder panel with a static ground detector, a three-phase watt-hour meter and volt-meter; the arc feeder panel is unifom with the rest of the board.

There are two arc circuits each provided with a 25-light transformer and a regulator of the "A. B." type which carry 38 2,000-cp Adams-Bagnall lamps. Additional street lighting is provided by 60 50-cp incandescent street lamps. Provision is also made for 5,000 16-cp lamps for private use.

A graded system of charges has been adopted. Electric energy for 16-cp incandescent lamps for domestic use costs 25 cents per month, each, for three or less, 15 cents for the fourth to ninth, 9 cents for the tenth to the twelfth, 4 cents each for the next three, and 1.5 cents per month each for all in excess of fifteen. For stores and offices the rate for the first ten lamps is 35 cents each per month, 30 cents for the next ten, 25 cents for the next ten, 20 cents for the next, and 10 cents a month for each in excess of forty. The rate for churches is 5 cents per month per lamp.

The charge for arc lamps not exceeding 1,200 cp is forty dollars per year, and for those exceeding 1,200 cp, it is fifty dollars per year.

The Orling-Armstrong System of Wireless Telegraphy and Telephony.

BY A. FREDERICK COLLINS.

THE many different forms of wireless telegraph apparatus devised since the original essays of Marconi have, with one exception, been based, fundamentally, on the indication of electric waves, the variance to the rule in question being that of the "Armorl" system, as its designers, Messrs. Orling and Armstrong, have chosen to name it. The grouping of certain electrical elements into this new arrangement for signaling through space without wires is stated to be founded on the dispersion or conduction of current electricity through the earth and water.

To carry out this idea, they designed a transmitter, Fig. 1, comprising an inductance coil, 1, an interruptor, 2, a condenser, 3, a battery, 4, a key, 5, and two grounded conductors, 6, 7. The receiver is made up of the two grounded conductors, 6, 7, Fig. 2, an electro-capillary relay, 8, a switch, 9, a second switch, 10, a battery, 11, and a Morse register, 12. The inductance coil is constructed like an ordinary sparking coil used for gas lighting and ignition apparatus of the wipe-spark type in gas engines. It is formed of a number of layers of insulated wires wound on an iron core and this is connected in series with the interruptor, the battery and the

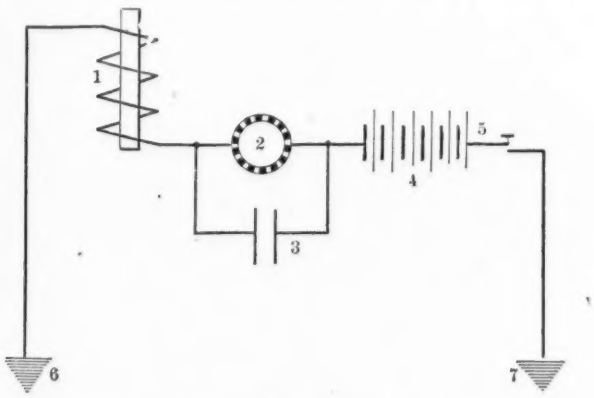


FIG. 1.—ARMORL TRANSMITTER.

immersed or buried plates, the object being apparently to take advantage of the effect on the current at the instant the circuit is broken. By this means it is claimed that the energy projected into the conducting medium by the transmitting system is "sufficient to actuate a suitable receiver through very considerable distances and while the earth connections are comparatively near to their respective stations." The distance between the local earth connections is stated to be "only a few yards," contact being made by iron spikes to which are attached the terminals of the base wires when the former are driven into the ground or are immersed in the water as circumstances require.

Shunted around the interruptor, which is of the revolving type,

is a condenser, the function of which is to produce a greater difference of potential at the terminals by permitting the primary current to charge the condenser while the break is taking place at the interruptor. The battery may be supplanted by a direct-current generator except in cases where portability is a requisite. The key is of the ordinary Morse form, although larger ones like those used in European systems of wireless telegraphy are sometimes employed where very heavy currents are to be broken.

The electro-capillary relay devised by Orling and Armstrong is employed in the receiving circuit to pick up the enfeebled impulses received through the earth or water and provides means for aug-

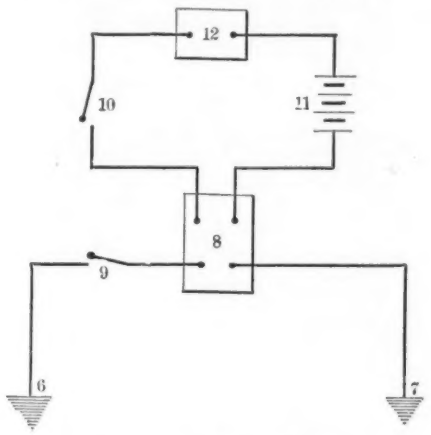


FIG. 2.—ARMORL RECEIVER.

menting these by closing a circuit in which there is interposed a battery and an ordinary Morse register; or the relay and register may be replaced by an electro-capillary recorder. The relay consists of a bent-tube syphon of which the shorter leg, *a*, Fig. 3, stands in a vessel of mercury, *c*, the longer leg, *b*, dipping into a vessel of acidulated water, *d*; the point of this leg is so finely drawn that the mercury is prevented from passing out of the orifice. But when even a minute current flows through the leg and out from the vessel of water, the mercury follows the current and falls from the bottom of the syphon in exceedingly fine drops. These fall on a globule of mercury which serves to seal an almost microscopic puncture in the bottom of the vessel of water, and the effect of each falling drop is to cause a corresponding drop to flow through the hole. The globules of mercury in thus passing through the orifice form a momentary contact between the metallic points of the relay, closing in consequence the operating circuit containing the register.

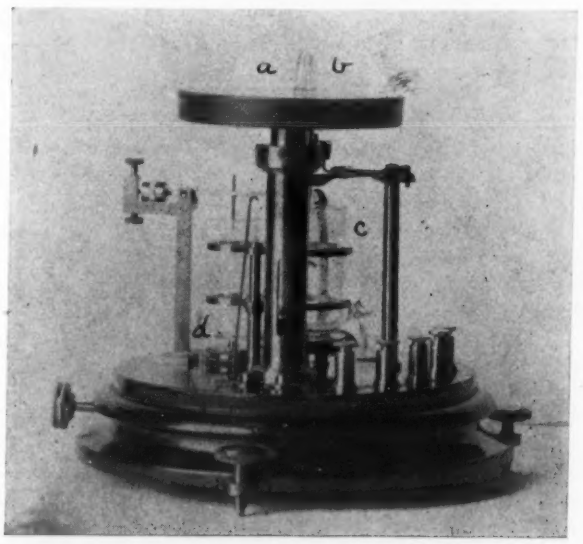


FIG. 3.—ELECTRO-CAPILLARY RELAY.

The electro-capillary recorder, Fig. 4, is constructed somewhat differently, though the instrument likewise comprises conductors of mercury and acidulated water; and as these two dissimilar fluids have no tendency to become either chemically or mechanically associated their surfaces are permitted to make contact with each other at a constricted part of the tube. When the signals are received the tension of one of the surfaces of contact is instantly varied, which causes the fluids in the tube to rise or fall according to the nature of the impulses. A beam of light is arranged to fall normally upon a moving photographic, i. e., sensitized tape, and when the electric currents are received, the beam is more or less screened by the movement of the opaque fluid and in this way a permanent record is produced. The electro-capillary recorder is also arranged for sight reading, as shown in Fig. 5.

The relay and recorder described possess, according to the inventors, an extremely high sensitivity, for, different from the ordinary relay and syphon recorder, there are no heavy moving masses such as armatures or coils of wire, and consequently there is no inertia to overcome; while the elimination of electromagnets reduces its resistance to a practically negligible point. The only moving part in the electro-capillary instruments consists simply of a fine thread of mercury the weight of which may likewise be considered nil.

The visible action of the Orling-Armstrong system may be summed up by saying that when the key of the transmitter (5) is made to close the circuit, the interruptor is set into action and the signals, whether dots or dashes, are made and broken in rapid succession through the inductance coil. The current from the battery energizes the inductance coil whenever the interruptor completes the circuit and induces an indirect extra current; while at every break a direct extra-current is induced, the result being that the induced extra current is caused to discharge itself through the conductors and into the earth. The conductors making contact with the earth are connected, as a reference to the diagram will show, on either side of the interruptor, and as a result the earth is put in series every time the circuit is broken by the interruptor; at every make

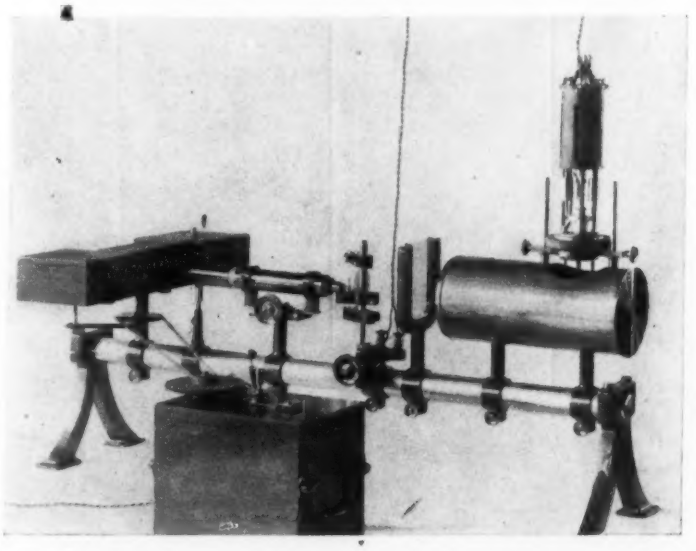


FIG. 4.—ELECTRO-CAPILLARY RECORDER WITH PHOTOGRAPHIC ATTACHMENT.

the resultant of the low-tension current and the inverse high potential extra current will be conducted to the earth while at every break the direct extra current, together with the maximum energy from the battery, will likewise be led to earth. In the transmitter, then, the high-potential extra current induced in the inductance coil by the break is projected into the earth simultaneously when the battery current is completed through the earth.

According to Dr. Maurice Ernest the invisible effects that this arrangement produces in the earth are as follows: At each of the points where a circuit is completed through the earth, the latter is charged electrically at one point positively and at the other negatively. Considering such a point by itself and ignoring for the moment the influence of other charges that may be in its neighborhood, it will be found that the electrical energy is continuously supplied to it and spreads out through the ground, radiating in every direction. This takes place owing to the mutual repulsion that every point of the charge has for every other part of the same charge, since all are of the same sign, being either all positive or all negative. This being true, the influence of such a charge may be considered to extend over the whole earth, but its potential at any point will obviously diminish with its distance from the source of supply.

Considering now that there is another similar but oppositely charged point in the neighborhood, in the absence of the first men-

tioned charge its energy would similarly spread out in all directions, but under the circumstances mentioned each charge would encroach upon the other; however, as these charges are of the opposite sign, they will mutually attract each other. The radiating repulsion lines of each charge that come within the attractive influence of the other will be deflected in consequence and so transformed into curves through which the energy of one charge will pass to the other. If now the terminals of the receiving instrument be connected at points of different potential with the earth—where it is traversed by the lines of current flow just described—some of the current will pass through it. This will, it is obvious, only be possible so long as there are lines of current flow where the receiver is located, and the latter will only then be able to operate the receiver if a sufficiently strong current is at hand.

What, then, will be the distance at which the radiating lines of force will be sufficiently strong to attract each other and so form lines of current flow from the base lines which join the two charges? This distance, it seems reasonable to assume, will depend upon the potential to which each of the points from which the current lines emanate. But owing to the numerous lines or paths through which the circuit is completed the current that would pass through a receiver would be very small indeed. This will be especially true if the terminals of the receiver are at points only a moderate distance apart, or if they cut one of the more remote lines. In order to produce really good results a current of considerable strength must, therefore, be available at the points whence the lines of force originate, or in other words, at the earth terminals of the transmitter.

This, it is stated by the inventors, is effected in their apparatus by completing a battery circuit through the earth simultaneously with

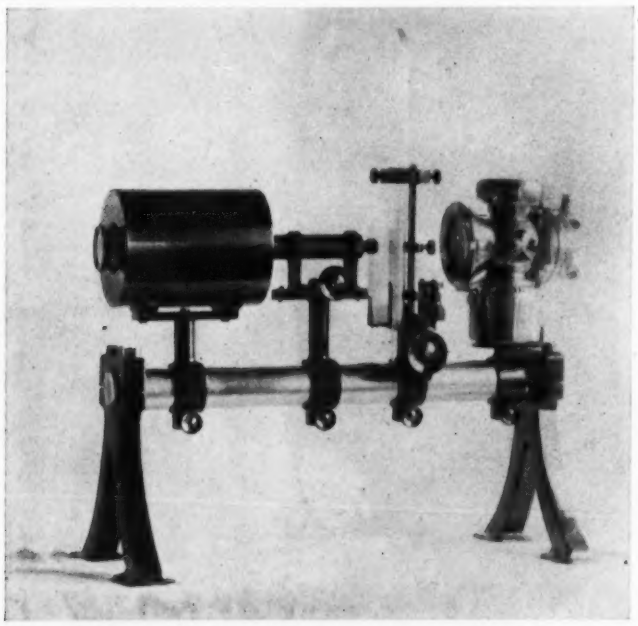


FIG. 5.—ELECTRO-CAPILLARY RECORDER FOR SIGHT READING ONLY.

a high-potential discharge at the earth connection, when lines of current flow are propagated that apparently constitute paths of low resistance through which the low voltage battery current passes. In this manner a sufficient quantity of electrical energy is propagated to a distant receiver which would operate a relay, and this in turn would actuate a Morse register or control any other desired apparatus.

The Orling-Armstrong system can be adapted to serve a large number of purposes, such as firing mines at a distance, controlling torpedoes, communicating between railway stations and trains in motion and working fire-alarms; in fact any instrument that is capable of being operated by a local battery or spring motor such as clocks, tape-machines and similar devices. By substituting a telephone transmitter for the key and interruptor and a telephone receiver for the relay and register, the arrangement may be converted into a wireless telephone.

Whatever may be the limitations of the so-called conductivity method this much may be said in its favor; it needs no high masts or other aerial devices, the instruments are not costly nor are they complicated, while they are extremely portable and may be fitted up in a few moments. This being the case, there is no doubt that the Armorl system will find its proper sphere like all other good things electrical, and it would seem to an interested observer on this side of the Atlantic that the army and navy should be the first to put it to a commercial test.

The Jones Phantoplex Telegraph System.

A system employing alternating currents of equal frequencies to be superimposed upon ordinary telegraph wires already being operated by the present Morse systems, either single, duplex or quadruplex, has recently been developed and patented by Mr. Fran-

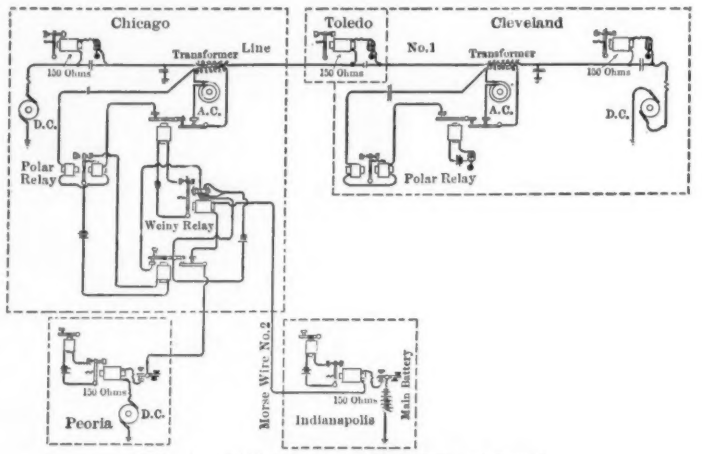


FIG. 1.—PHANTOPLEX REPEATER CIRCUITS.

cis W. Jones, electrical engineer, of the Postal Telegraph-Cable Company, for the purpose of adding additional facilities to present telegraph wires for the transmission of messages by the Morse code.

The utilization of alternating currents, both of equal and unequal frequencies, has been tried for the same purpose by many inventors, commencing many years ago with Cromwell F. Varley, in England. The most successful applications having been made in the United States by Thomas A. Edison, A. C. Crehore and Harry O. Rugh, whose systems have been in practical operation upon telegraph lines with more or less success, but which systems have not proved as satisfactory to telegraph managers as they desired. Elisha Gray's system for a similar purpose employed direct currents and therefore was dependent upon paths of non-inductive high resistance around his Morse apparatus to admit of the passage of his pulsatory sig-

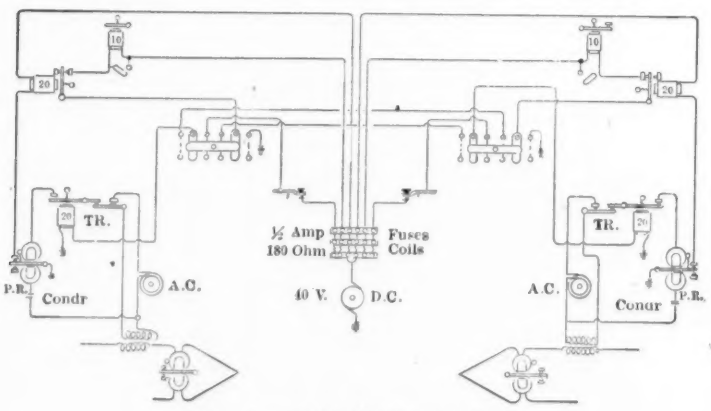


FIG. 2.—PHANTOPLEX REPEATER.

nals, and for this and other reasons the Gray system was not put in use by the telegraph company which controlled the patents.

Mr. Jones' system, which has been given the name of the "Phantoplex," on account of its creating what is known as a "phantom" circuit, has been in practical operation upon the wires of the Postal Telegraph-Cable Company for several months, and the results of its operation are stated to be highly satisfactory.

The alternating currents employed have a frequency of about 150 per second, and an effective e.m.f. of about 100 volts, for an ordinary telegraph circuit about three hundred miles long, not including way offices. The transformer has been designed to make

a transformation of maximum efficiency, of the alternating currents, in the line wire; a capacity of at least six microfarads has been given to each condenser placed around the relays, and at the ends of the Morse circuit, to furnish an electrostatic path of low impedance for such transformed alternating currents. It is found that the currents used for "Phantoplex" signals, on account of their high rate of alternation do not affect the Morse apparatus, either in the circuit being operated, or in a circuit being operated upon an adjacent wire upon the same cross arms. It is well known that if a speaking telephone circuit is established through the coils of a sensitive astatic galvanometer, that the mirror of the latter will not be set in motion by the operation of the telephone, the electric sound waves in the telephone being of high and variable frequencies; but if an instrument as sensitive as the Bell receiver is included in the circuit, the electric sound waves will set its diaphragm into audible motion; similarly the ordinary Morse relays connected directly in the "Phantoplex" wires, or which are being operated in a wire adjacent thereto, are immune from the effect of such currents, but they are likely to produce a hum or note corresponding to their rate per second in any unbalanced telephone wire running parallel within a short distance of the "Phantoplex" circuit.

The Jones system was worked satisfactorily between New York and Hartford, 142 miles, upon a wire that was being worked quadruplex between New York and Boston, 260 miles, and not the slightest interference could be detected between one system and the other. In fact, the operators working upon the quadruplex could in no manner be aware when the "Phantoplex" was in operation; neither could the operators upon the "Phantoplex" circuit tell when the quadruplex was being operated.

A "Phantoplex" circuit is being operated between New York and Utica, 300 miles, upon a wire that is duplexed between New York

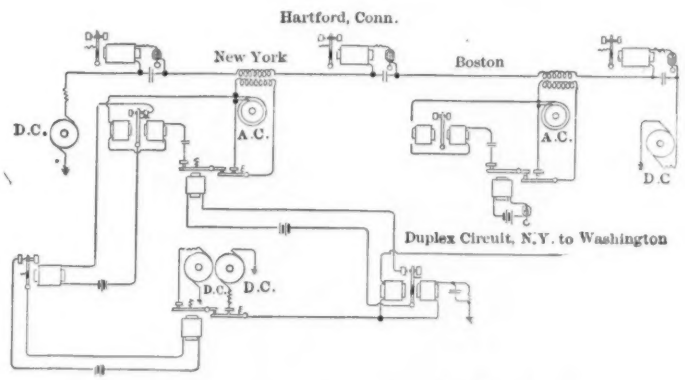


FIG. 3.—PHANTOPLEX CIRCUITS NEW YORK TO BOSTON.

and Buffalo, 450 miles, in the most perfect manner and without the slightest interference. This wire contains about ten miles of underground, and one mile of submarine cable. There is no reason to believe that this system will not work through much greater lengths of underground and submarine cable than the speaking telephone, on account of its containing no overtone alternations for the purpose of reproducing speech. Many other circuits under similar conditions are being operated with the same results.

A number of patents have been granted to Mr. Jones on this system. One broadly covers the particular combination and means for "Phantoplex" sending and receiving; also for superposing the system upon the ordinary polarized Morse duplex circuit, by which two "Phantoplex" communications can be made simultaneously in opposite directions, at the same time that two Morse messages are being transmitted in opposite directions. Another shows the connections for the superposition of the "Phantoplex" upon a duplexed or quadruplexed wire. In this case, the wire between the stations is utilized for "Phantoplex" transmission in either direction, while the duplex or quadruplex apparatus is being operated for the transmission of messages by the Morse system in the usual manner. Still another shows a means for repeating from a "Phantoplex" circuit upon one Morse wire directly into another Morse wire not equipped with "Phantoplex" apparatus. The second Morse circuit, marked No. 2 in Fig. 1, should be equipped with keys which open and close the line at the under side of the rear end of the lever, instead of at the contact point, as shown under the end of the lever upon which the knob is mounted; and the sounders of the relays should be operated from the back contact points of the Morse relays that are worked in this circuit. This can be easily arranged by the use of special keys, and three-point switches to change the key contacts and local sounder contacts from front to rear.

Fig. 2 shows a "Phantoplex" repeater for carrying the signals from an eastern duplexed wire at any repeater station, over a western duplexed wire, and vice versa, with switches for separating the "Phantoplex" sets, so that they may be worked independently both east and west from the repeater station. The same repeater answers for wires that are being worked single or quadruplex. Fig. 3 is a plan for connecting a "Phantoplex" circuit, being worked upon a way wire between New York and Boston, with a duplexed circuit in the New York office, operated by the Morse system between New York and Washington, as shown. When Boston is sending by "Phantoplex" to Washington via the New York "Phantoplex" repeater, it is necessary for Washington to keep his key open, instead of closed, as is the case at present when Morse wires are connected to duplex circuits through half repeaters.

LETTERS TO THE EDITORS.

Wire Calculations by the Slide-Rule.

To the Editors of Electrical World and Engineer:

SIRS:—The formula for calculating with the slide-rule the size of wire required for given distance, current, and drop, as given by Mr. W. F. White in the issue of *Electrical World and Engineer* for October 14, may be greatly simplified by replacing the unwieldy constant term by a simple and easily remembered constant factor, and at the same time the addition required by his formula is eliminated so that the result as read from the logarithm scale is the number of wire sought. The following explanation will make clear the change suggested and the manner of using the formula:

Mr. White's formula (5)

$$2^{\frac{n}{3}} = 5{,}000\,\frac{V}{D \times I} \qquad (1)$$

may be written approximately

$$\frac{n}{10} = log\left(\frac{5{,}000 \times V}{D \times I}\right) \qquad (2)$$

or

$$n = 10\ log\left(\frac{5{,}000 \times V}{D \times I}\right) \qquad (3)$$

To solve a problem with this formula it is only necessary to substitute values and solve the fraction within the parenthesis, using the C and D scales, then turn the rule over and read the number directly on the logarithm scale. To illustrate, take the conditions given by Mr. Austin Burt in the issue for November 25:

$V = 3.5$ = drop in volts,
$D = 74$ = distance in feet,
$I = 95$ = load in amperes.

substituting in formula (3)

$$n = 10\ log\left(\frac{5{,}000 \times 3.5}{74 \times 95}\right)$$

After performing the operations indicated within the parenthesis, using the C and D scales, the ten of the C scale will be found to be opposite 2.47 on the D scale and the logarithm of this number, which is .396, may be read on the L scale opposite the left-hand index, or, if the rule has no index line at the left-hand end on the back, the slide may be advanced its length to the right and the logarithm read opposite the right-hand index. Therefore,

$n = 10 \times .396 = 3.96$, or approximately No. 4 wire.

If the load in the above problem were 9.5 amp. and the other conditions the same the quantity within the parenthesis would be 24.7 and the logarithm would be 1.396; hence,

$n = 1.396 \times 10 = 13.96$, or approximately No. 14 wire;

or again, if the current were 400 amp., the distance and drop remaining the same the quantity within the parenthesis reduces to .591, the logarithm of which is $\bar{1}.772$ and the number of the wire is

$n = \bar{1}.772 \times 10 = -2.28$, or between No. 000 and No. 0000. Nos. 00, 000 and 0000 are taken as —1, —2 and —3.

Account must always be taken of the characteristic of the logarithm of the quantity within the parenthesis as it becomes the tens digit, if there is one, of the number representing the size of the wire, or if it is negative shows that the wire is larger than No. 0.

WAUKON, IOWA. M. S. HOWARD.

Swedish Government Electric Traction Experiments.

To the Editors of Electrical World and Engineer:

SIRS:—Will you permit me to make several corrections in the report in your issue of November 11 of the paper on Swedish Government Electric Traction Experiments, which I presented at the recent Congress of Swedish Engineers.

In comparing the three-phase and single-phase systems with respect to cost of feeders, I pointed out that it is most equitable to assume the same voltage in both cases between the conductors and the grounded neutral point, rather than between the conductors themselves. With the same voltage to ground, the same amount of copper is needed in both cases, and as the single-phase line requires less insulators, my conclusion was that the total cost of the feeders is rather less for single-phase than for three-phase. I therefore expressed the opinion that with respect to the line the advantages are on the single-phase side. In my general conclusion in favor of this system, I pointed out that for certain railroads with conditions differing from those of Swedish lines, the three-phase system might perhaps show up more favorably in the present stage of the art.

Concerning the Oerlikon system, I stated, in direct contradiction to the report, that I should like to have a part of the line constructed according to that system, and that I had made a great effort to this end and had good hope of seeing it realized.

In your editorial you remark that in view of the Zossen work, one may be permitted to doubt whether higher voltage in the contact line can be used with single-phase than with three-phase current. Allow me to point out, as I stated also in my paper, that the Zossen line is a special case, as there was no limit to space and no switches were used. The line construction of the Zossen line cannot be employed for ordinary railroads—certainly not for our Swedish roads—and it seems quite clear to me that a single wire in narrow tunnels, at street crossings, on bridges and at switches, is better than two wires, and that a higher voltage can be used on a single-phase trolley conductor.

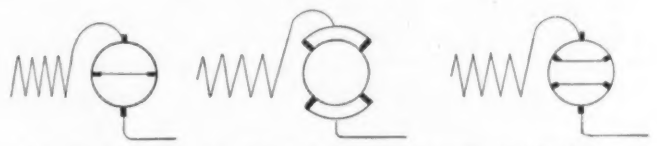
STOCKHOLM, SWEDEN. R. DAHLANDER.

[We regret the error noted with reference to the comparison of the cost of feeders for single-phase and three-phase railway systems. We find that this error is not chargeable to our correspondent, the words in his report "for the same voltage to ground" having been omitted in setting up the type. The reference to the Oerlikon system, which is criticized, reads in the report, "Mr. Dahlander stated that this system had been taken into consideration, but for many reasons it had not been decided to try it in the present experiments." We are glad to learn from Mr. Dahlander's letter that it is part of the Swedish programme to take up this system later for experimental investigation.—EDS.]

Belgian Single-phase Railway.

To the Editors of Electrical World and Engineer:

SIRS:—In a letter that appeared in your issue of December 9 1905, the Allgemeine Elektricitäts Gesellschaft, of Berlin, claims that the Belgian Latour patents which it controls "cover, at most, some details of its system." To show the nature of these details I wish to state that these Belgian patents cover three forms of single-phase motors, represented diagrammatically on the accompanying sketches, Figs. 1, 2 and 3. Fig. 1, in particular, represents a series-motor possessing a distributed winding on the stator and two brushes displaced 90 degrees from the brushes introducing the line current into the rotor. The series connection may be made at will by means of a current transformer. To my mind, these peculiarities in the construction adopted for the Borinage motors are sufficient to justify these motors being called motors of my type, if the name of any



FIGS. 1, 2 AND 3.—DIAGRAMS OF SINGLE-PHASE MOTORS.

person is used at all. However, I never had any intention to produce the impression of having designed the particular motors in question or having patented the other details of the system exterior to the motors. This will be sufficient to make the situation in Belgium clear.

As to the question of the absolute priority of the invention of the form of single-phase motor (Fig. 1) it would be useless to discuss it here. My opinion naturally differs from that of the engineers the Allgemeine Elektricitäts Gesellschaft.

NEW YORK. M. LATOUR.

Practical Vector Diagram for Induction Motors.

To the Editors of Electrical World and Engineer:

SIRS:—I should like to call attention to some misprints in my article entitled "A Practical Vector Diagram for Induction Motors," which appeared in your issue of February 25, 1905.

Page 391, column 1, line 16, should read "See Fig. 13."

Page 394, column 1, line 9, should read:

$$\tan \epsilon = \frac{I_0'}{E}\left[r_1 + \frac{r_2}{2} + 2\,(x_1 + x_2)\,\cos\,\phi_0'\right] = .20.$$

And line 17 should read:

$$\tan \alpha = \frac{E\,b_c - (x_1 + x_2)\,T^2}{r_1 + \frac{r_2}{2}\Big)T^2 - Eg_c - 2d\left[b_c\left(r_1' + \frac{r_2}{2}\right) - g_c\,(x_1 + x_2)\right]}$$

WILKINSBURG, PA. H. C. SPECHT.

The Metallized Filament Lamp.

To the Editors of Electrical World and Engineer:

SIRS:—Several articles have appeared of late in the technical journals showing a very considerable misunderstanding of the nature of the invention underlying the new metallized filament incandescent lamp of the General Electric Company.

I do not care to take your space to discuss patent matters, but I think it only fair to other manufacturers of incandescent lamps to state that we are of the opinion that the statements above referred to are based on an entire misunderstanding of the lamp and of the invention.

SCHENECTADY, N. Y. ALBERT G. DAVIS.

[In absence of specific reference by Mr. Davis, we can perhaps help our readers by directing their attention to one article on this subject, appearing in our issue of November 25, 1905, by Mr. E. P. Thompson, page 892, entitled "Graphitizing Filament Patents Expired."—EDS. E. W. AND E.]

The Patent Law Situation.

To the Editors of Electrical World and Engineer:

SIRS:—The communication from an unnamed patent attorney under the head, "The Patent Law Situation," which appears in your issue of November 25, is interesting as well as valuable. However, a great divergence of opinion may exist according to experi-

ence. The attorney's experience given in the first paragraph leads one to believe that there are few, if any, evils to correct, and that since the two judges which did not come up to the requirements are not practicing, everything is lovely, and the courts leave nothing to be desired. The electrical engineering profession would be happy if this state did exist, but unfortunately it has met many color-blind judges.

The second paragraph of the article does not appear quite logical. People with patents obtained fraudulently cannot stand any chance before any court and hence cannot extort money; and the rich defendant can hold out longer probably than a poorer plaintiff. A court may not understand everything about the contents of a patent, but if it knows the same to be fraudulent, would dismiss the case.

Paragraphs 3 and 4 will, no doubt, be upheld by all who are able to judge. Paragraph 5 reveals a misunderstanding by your correspondent, and the communication in your issue of November 18 fully explains the expert assistance desired.

With regard to paragraph 6, I may say that it is not necessary that the lower court or advisory board mentioned in the issue of November 18 should be a department of the Patent Office. If necessary or desirable, it may be entirely separated therefrom. The features desired are: First, that the judges should have been Patent-Office examiners; second, that they should know the state of the art; and third, that they should have access to the Patent Office Library and have all the privileges a Patent Office examiner enjoys.

Regarding paragraph 9, it may be true that this "subject has been repeatedly threshed out by the parties who know most about it." If I am not mistaken the threshing has been going on for the last fifteen years, but we are yet anxiously awaiting the harvest.

ST. LOUIS, MO. LUDWIG GUTMANN.

DIGEST OF CURRENT ELECTRICAL LITERATURE

DYNAMOS, MOTORS AND TRANSFORMERS.

Theory of Single-Phase Induction Motor.—THOMAELEN.—The first part of a theoretical paper on the theory of the single-phase induction motor, discussing the resolution of the magnetomotive force of the single-phase motor into two magnetomotive forces revolving in opposite directions. After a general introduction the author deals with the conception of a "revolving excitation"; he then assumes a sinusoidal winding and discusses the substitution of two excitations revolving in opposite directions for the single-phase excitation. He then passes to the discussion of the single-phase motor with a rotor of zero resistance at synchronism, and finally calculates the rotor current (taking into account the rotor resistance and the slip), the loss in the rotor, the e.m.f. of the stator and the energy supplied.—*Elek. Zeit.*, December 7.

Single-Phase Commutator Motors.—HOERBURG.—The first part an article, illustrated by diagrams, giving a review of the different types of single-phase commutator motors.—*Dingler's Polyt. Jour.*, November 25.

Small Direct-Current Motor.—COLEMAN.—A fully illustrated article giving detailed drawings of the design of a small motor for operating railroad semaphore signals. The armature is entirely enclosed and the motor runs at the speed of 2,256 revolutions per minute when supplied from a battery at the potential of 11 volts, using ½ ampere.—*Am. Electrician*, December.

Tests of Transformers.—DRUCBERT.—The conclusion of his mathematical article illustrated by diagrams. The author shows how the behavior of a transformer may be determined by two simple tests at no-load and on short-circuit, whereby it must be considered that the accuracy of the results depends essentially on the curve of the applied e.m.f. A sine curve appears to be the most suitable for testing.—*L'Eclairage Elec.*, November 18.

Magnet Windings.—UNDERHILL.—An article giving charts which enables one easily to determine, without calculation, the proper size of wire to use in the windings of electromagnets.—*Am. Electrician*, December.

LIGHTS AND LIGHTING.

Arc Lamps.—Some notes on arc lamps made by the Gilbert Arc Lamp Company of England. The diagram of a complete end-post with lowering gear, as shown in Fig. 1, indicates the various appliances for which room must be found inside the post, and is self-explanatory. Reference is then made to a flame-arc lamp made by this company. The lamp is made on the lines of German flame-arc lamps so far as its general arrangements are concerned, but, in place of a clockwork-feeding mechanism, there is a rocking lever and brake wheel such as is employed in a large number of ordinary English lamps. To get over the difficulty of short-life of carbons, the lamp is of the double-carbon pattern, and the two pairs of carbons are connected to the same holders. In this way, as soon as the first pair of carbons has burned away a certain extent, the second pair come together and strike an arc, and they take up the running until in their turn they have burned away sufficiently. It is claimed that there is only a flicker and no serious "pumping" when this occurs. The mechanism is placed in the top of the V formed by the two carbons so that the length of the lamp is reduced as much as possible.—Lond. *Elec.*, December 8.

POWER.

French Water Power Station.—STEENS.—A description of the hydro-electric station at Champ which furnishes electric power to various industrial establishments in the vicinity of the Fure and Morge valleys, not far from Grenoble. There are five 1,350-hp generating units, giving three-phase, 50-cycle currents at 3,000 volts. For transmission the voltage is raised to 15,000 or 26,000, according to the method of connecting the transformers. Current is furnished to 57 consumers, the main line being 30 km. long with various branches. At 11 sub-stations the voltage is reduced to 2,000 or 1,000. Certain consumers utilize the 1,000-volt current without further change, but the majority prefer to reduce the voltage to 120. The company owning the works has a capital of 5,000,000 francs, invested in the installation, equivalent to approximately 1,200 francs per electric horse power at the consumers' works or 550 francs per

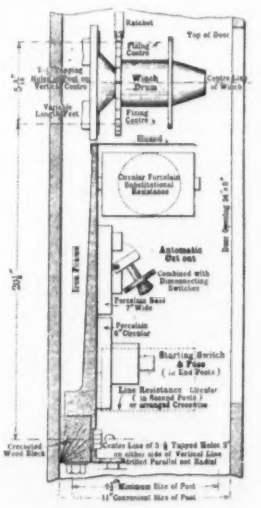


FIG. 1.—ARC LAMPS.

water horse power. A syndicate of leading manufacturers in the district supplied with power agreed to take 3,000 hp before the construction of the works, and at the expiration of thirty years will take over the plant. With 3,300 hp already contracted for, there is assured an annual income of 475,000 francs, which will rise to 600,000 francs when the entire output is taken. In spite of the amortization in the short period of thirty years, it seems probable that the investment of the company in the plant will yield about 8 per cent.—*Eng'ing Record*, December 9.

Refuse Destructors.—WATSON.—A paper read before the Leeds section of the (Brit.) Inst. of Elec. Engs., giving many useful points as to the operation of refuse destructors and their by-products, especially the methods of taking off the gases of combustion, and the methods of applying forced draught to the furnaces. The author says that when all proper precautions have been taken in the construction and working of the plant, a destructor is a source of no nuisance whatever, and the only inconvenience of which the

neighbors could possibly complain is that due to the carting of the refuse through the streets. Details are given of an official 12-hour test of the Batley destructor, 1.60 lb. of steam being produced per pound of refuse. In a one-week test at Bradford the total electrical output for the week was 50,638 kw-hours, and the refuse burned was nearly 833 tons, so that the output per ton was 60 kw-hours, which is good for a continuous result, inasmuch as all of the steam used by the auxiliaries and blown off through the safety valve, was also raised by the destructor itself.—Lond. *Elec.*, December 1.

Composite Transmission.—BRUELL.—An article on the transmission of alternating currents of different frequency over a line. The author first discusses the general problem of transmitting two frequencies, one N times that of the other one, and then applies it to the case $N = 3$. For motors, low frequency is more suitable, while lamps operate better with a high frequency. Fig. 2 shows

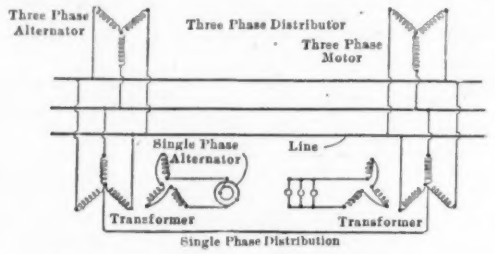


FIG. 2.—COMPOSITE TRANSMISSION.

his scheme for transmitting three-phase currents with a frequency, n, and single-phase alternating-current with a frequency, $3n$. The single-phase alternator and the single-phase lamp load are connected to the three-phase line through the intermediary of transformers.—*L'Industrie Elec.*, October 25.

Italian Power Transmission.—RAMAKERS.—An illustrated article on the transmission plant at Montereale-Cellina, which supplies Venice with power for lamps and motors. There are four 2,600-hp turbines driving 4,000-volt, three-phase alternators. The transmission voltage is 30,000.—*Am. Electrician*, December.

Electrically-Driven Refrigerating Plant.—An illustrated description of a modern cold storage plant in which the ammonia compressors are electrically driven by means of direct-coupled variable-speed motors, an arrangement naturally tending to extreme compactness and easy manipulation in comparison with that necessary with steam or gas-driven plants; electric driving and lighting has been adopted throughout.—Lond. *Elec. Rev.*, December 1.

Textile Works.—KNOWLTON.—An article recommending the use of direct-connected motors in textile works. While the first cost is probably higher than the group system of driving, direct-connected motors have distinct advantages, besides the lower cost of power.—*Am. Electrician*, December.

Electricity in Mines.—MACK.—An illustrated article on the best arrangement of the switchboard and wiring in high-tension installations in mines.—*Elek. Zeit.*, November 30.

Direct-Current Motors.—CLARK.—An article giving some general points to be considered in the selection of direct-current motors.—*Cassier's Mag.*, December.

Boiler Power.—HUBBARD.—An article telling how to estimate quickly the boiler capacity required for heating, lighting and power purposes.—*Am. Electrician*, December.

Gas Engines.—MATHOT.—An explanation of the action, efficiency and limitations of various methods of governing four-cycle gas engines.—*Eng'ing Mag.*, December.

Gas Producers.—RICHARDS.—In the continuation of his serial on metallurgical calculations, he discusses mixed gas producers.—*Electrochem. and Met. Ind.*, December.

Steam Turbines.—MARGUERRE AND ANDERS.—Two communications on graphical methods for determining the efficiency of steam turbines.—*Elek. Zeit.*, November 16.

TRACTION.

Electric Railway Equipment.—Some editorial comments on W. B. Potter's recent paper before the Amer. Street Railway Assoc. "Sparking from uneven wear of copper and mica at the commutator is a rare trouble nowadays in England, and the remedy suggested by Mr. Potter strikes one as being dangerous. Probably the use of a softer quality of mica would be advantageous, but from the remark as to the larger number of commutator segments now used it seems likely that manufacturers have been driven to the use of thinner mica of harder kinds, such as Indian mica. The suggestion of a cooling fan to assist the ventilation of traction motors is highly significant of the near approach to the practical limits of the power that can be applied to standard gauge axle within the usual wheel heights. The space in locomotives is not so severely limited, and it would seem practicable and more economical to make the motor do its own fanning in every case." . . . "The technical Americanese of the whole paper is a development which we trust will not be extensively copied in England, though it has some virtues."—Lond. *Elec.*, December 2.

Belfast.—An illustrated description of the Belfast municipal tramways. The generating station forms an extension of the electrical central station. Its site has been chosen as a suitable point for distributing energy for the city's requirements both for lighting and traction purposes, and the plant has been arranged with this object in view. The generators are provided with con pound windings for tramway supply at 550 volts, and when run as shunt machines for lighting they supply a pressure of from 440 to 500 volts for the outers of the three-wire system. The total capacity is now 3,400 kw. To outlaying sub-stations three-phase currents are transmitted at 6,000 volts.—Lond. *Elec.*, December 1.

Swiss Electric Railway.—GUARINI.—An illustrated description of the electric trolley line of Gruyeres in the Cantons of Freiburg in Switzerland. Energy is supplied from the water power station at Mont Boven.—*Eng'ing Mag.*, December.

Single-Phase Traction.—ZEHME.—An illustrated article on the single-phase traction experiments on a Paris line with the Latour system. The subject has already been dealt with in the Digest.—*Elek. Zeit.*, December 7.

Electric Automobiles.—An illustrated description of the Vedrine electric carriage which is an automobile of French make. Regulation of speed is obtained entirely by the variation of the magnetic field of the motor. The speed range of the motor is from 500 to 1,600 revolutions per minute.—Lond. *Elec. Rev.*, December 1.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Determination of Dynamo-Shunt Rheostats.—An article on determining the amount of regulating resistance for any required voltage variation, and conversely on determining the amount of regulation that may be obtained by using a given regulator resistance in the field circuit of a given shunt dynamo. For the method nothing is required but the magnetic no-load characteristic curve of the machine in question, the machine terminal volts being plotted against actual amperes excitation. Having the desired saturation curve, $A\ B\ C$, in Fig. 3, and taking, first, the case in which it is re-

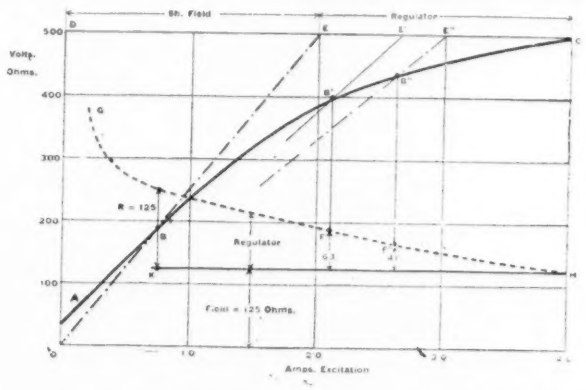


FIG. 3.—DETERMINATION OF RESISTANCE OF SHUNT RHEOSTATS.

quired to determine the voltage regulation obtained on the dynamo by the use of a certain resistance of known amount, from C, the point on the curve corresponding to the normal voltage of the machine, draw $C\ D$ horizontally. If this line, $C\ D$, is divided at E into two parts proportional to the amounts of resistance of the shunt field coils (hot) and the regulator resistance respectively, as indicated, a straight line joining E to the origin, O, will cut the saturation curve at a point, B, corresponding to the resultant stable voltage of the dynamo with the given resistance in the shunt field circuit. Conversely, to determine the resistance required to obtain a given voltage range, it will be seen that if a line joining the point, O, to a point on $A\ B\ C$ representing the lowest voltage required, be produced to cut $D\ C$, then the proportion between the two parts of $D\ C$ so cut will indicate the necessary proportion between the resistances of the shunt field circuit and the regulator.

The other method of obtaining these results is to calculate from the volt-ampere curve a second curve of ampere-ohms, which shows the total resistance in the shunt circuit corresponding to any point on the saturation curve. This total resistance curve is shown at *G F H*, the distance, *F K*, representing the regulator resistance, and the distance of *H K* from the base-line the (constant) amount of the shunt field circuit. The two methods give identical results.—Lond. *Elec. Rev.*, December 1.

German Central Station.—SEYFFERT.—Some statistical notes from the annual report of the German Assoc. of Central Stations. One hundred and ninety-three stations belong to the association, of which 73 are municipal and 120 are owned by corporations. One hundred and twenty-seven use direct-current, 23 single-phase or three-phase current and 43 combined direct and alternating-current. One hundred and thirty-nine plants give electric energy for lighting and power, one for traction and 53 for lighting, power and traction. Considerable statistical data are given, and it is pointed out that to get good financial results it is absolutely necessary to make the first cost as low as possible. It is thought that the first cost per kw of capacity should not be more than $325 or $375. One of the most expensive stations is in Liegnitz where the capital invested is $700 per kw, while the lowest values of the capital invested are about $100 per kw.—*Zeit. f. Beleucht.*, November 20 and 30.

Automatic Earthing Devices.—In some notes on the Alexandria-Remleh Electric railway the provision of automatic earthing forks under each line wire upon both sides of each insulator is mentioned. If a high-voltage wire breaks it drops into the fork and is immediately earthed.—Lond. *Elec.*, November 24.

WIRES, WIRING AND CONDUITS.

Wiring.—AUERBACHER.—An article on "electric contract work," giving practical rules on the construction of two-wire and three-wire systems, the calculation of the size of conductors, etc. The article is illustrated by numerous diagrams.—*Am. Electrician*, December.

Calculating Net Works.—SOSCHINSKI.—A highly mathematical article on calculating net works and on an approximate method of Gauss for solving the series of equations in such problems.—*Elek. Zeit.*, November 23, 30.

ELECTROPHYSICS AND MAGNETISM.

Spark Length and E.M.F.—HOBBS.—In former researches on the relation between the potential difference and spark length the linear relation between spark-potential and distance for comparatively large values of the latter was established, and Peace noticed the existence of a minimum spark-potential. Paschen deduced from a large number of observations the law that for given potential differences the product of the sparking distance and the maximum gas pressure is a constant. Later on some experiments have been made on sparks between very small distances and these have been continued by the present author. He finds that the material of which the electrodes are composed exerts an important influence upon the spark potential at small distances and that the carriers of the discharge for small distances come from the metal and not from the gas. Some of his chief results are as follows: With one spherical and one plane electrode, at constant pressure the spark-potential is directly proportional to the distances between the electrodes, until the potential reaches the minimum value for the gas. In any gas the potential of discharge reaches its minimum value for the gas at distances which are inversely proportional to the gas pressures existing between the electrodes. For the same electrodes the discharge at distances from zero to about 3μ is wholly independent of the gas pressure or of the nature of the gas between the electrodes. For the same electrodes the distances at which the curves assume a horizontal slope are proportional to the minimum spark-potential of the gas between the electrodes. When a discharge of electricity occurs between two electrodes at a lower potential than the minimum spark-potential of the gas in which the discharge occurs, the discharge is produced wholly or in part by the metal ions.—*Phil. Mag.*, December.

Resistance of Selenium.—COSTE.—An article pointing out that there are many sources of error in the usual way of measuring the electric resistance of selenium, by fusing it between two metallic plates. By rapid cooling, a vitreous form is obtained, which is insulating. By annealing, it is transformed into metallic selenium, which is conducting. Selenium combines with most metals, and it thus usually contains selenides when fused in contact with them. That this is the case has been proved by the author, who fused selenium on gold leaf and then drove it off by heat, when it left a residue of pure gold. The resistance usually attributed to selenium is untrustworthy for that reason. Carbon electrodes are not open to this objection, and the author has, therefore, operated with these. When the vitreous selenium is transformed into the metallic variety, it shows under the microscope a number of fissures, their number varying greatly with the mode of transformation and the rate of cooling. Hence the different results obtained by various observers. In spite of the fissures, the metallic variety is denser than the vitreous. The contraction commences on the surface, and leaves the fissures as it proceeds inwards. When light impinges on the selenium, some fissures are bridged, and the resistance thus decreased. The author found a resistance of 86,000 ohms in a stick 9 cm. long and of ½ sq. mm. sectional area.—Lond. *Elec.*, December 1; from *Comptes Rendus*, November 6.

Electrostriction.—MORE.—A paper on the dielectric strain along the lines of force. The author describes very carefully experiments showing that the effects which have been observed by himself and others can be fully accounted for by extraneous effects and that when these are eliminated the distortion of the dielectrics by an electrical charge also vanishes.—*Phil. Mag.*, December.

Electricity Through Gases.—ROBB.—A second paper of a highly mathematical nature on the conduction of electricity through gases between parallel plates.—*Phil. Mag.*, December.

Ionization of Gases.—LEWIS.—An account of an experimental investigation of the ionization in gases from colored flames The author discusses the specific velocity of the ions, the rate of recombination, the relation between concentration and conductivity, and the total ionization at the boundaries of the flame.—*Phys. Rev.*, December.

Thermoelectricity.—SCHMITZ.—An account of experiments on thermoelectricity circuits formed of three metals, the three junctions being held at different temperatures. The results are given in tables.—*Phil. Mag.*, December.

Magnetization.—HONDA AND SHIMIZU.—The conclusion of their very extended investigation of the magnetization and the magnetic change of length in ferro-magnetic metals and alloys, at temperatures ranging from −186° C. to +1,200° C. Especially extended researches were made with nickel steels, and a general rule is given for the effect of a gradual variation of temperature. A suggestion is made to explain why two strongly magnetic metals may form a non-magnetic metal.—*Phil. Mag.*, December.

Rotating Hysteresis.—HIECKE AND HERMANN.—Two communications of a mathematical nature on the measurement of the "rotating hysteresis."—*Elek. Zeit.*, November 23.

ELECTROCHEMISTRY AND BATTERIES.

Electric Furnace.—HUTTON AND PATTERSON.—An illustrated Faraday Society paper on electrically-heated carbon tube furnaces. The author describes two different constructions, the first being a graphite tube furnace and the second an agglomerated-carbon tube furnace. Experiments were also made with different jacketing materials. One of the chief advantages of this type of electric resistance furnace lies in the fact that the temperature can be very easily regulated and kept constant.—*Electrochem. and Met. Ind.*, December.

Estimation of Cadmium.—FLORA.—A note on the electrolytic estimation of cadmium with the aid of the rotating cathode. Cadmium sulphate is best fitted for electrolytic analysis.—*Am. Jour. of Science*, December.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing of Generators and Motors.—DRYSDALE.—A paper profusely illustrated by diagrams. The author describes an arrangement which he has devised for a laboratory whereby small motors of different types, powers and speeds can be rapidly and accurately tested. The chief point is the use of a generator permitting of a very wide range of speed and excitation, and mounted with its armature free to rotate; the excitation is varied until the machine can be switched into parallel with the 100-volt, direct-current mains. Any increase of the excitation loads the generator, and hence the motor coupled to it, by sending the current back into the mains without waste or heating; while if, on the other hand, the excitation is reduced, the load can be reduced to zero or become negative, the generator boming a motor and driving the machine to be tested as

a generator, either direct-current or synchronous or asynchronous, as the case might be. The arrangement is illustrated in Fig. 4. *G* is the generator, a four-pole, 8-kw direct-current machine giving 100 volts at any speed between 750 and 1,600 revolutions per minute. This machine is provided with ball races, *B, B,* cut on the

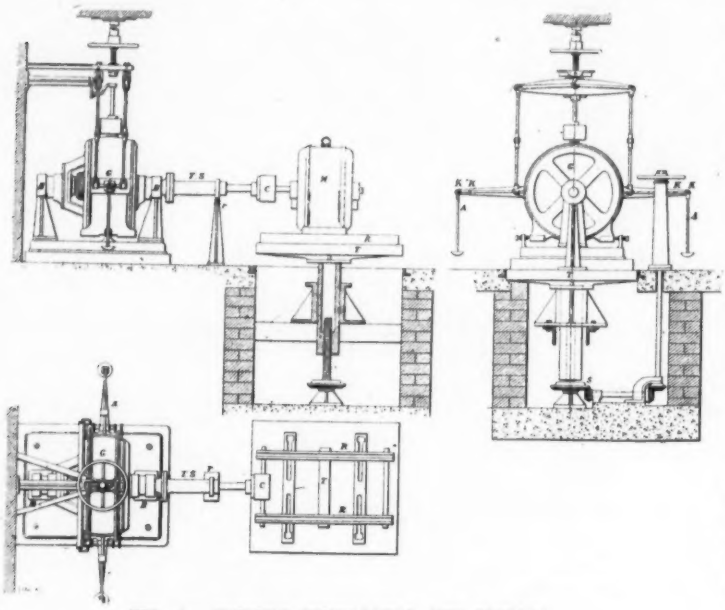


FIG. 4.—TESTING GENERATORS AND MOTORS.

outside of the bearings and supported on ½-in. balls from a rigid bed-plate. To measure the torque, two gun-metal arms, *A, A,* are fitted to the sides of the motor, with knife-edges from which weights can be hung. Each of these arms has two knife-edges, *K, K,* one at a distance of 31½ in. from the axis, and the other 28.1 in. When the shaft is running at 1,000 revolutions per minute, a weight of 2 lb. on the outer knife-edge represents 1 hp, while a weight of 3 lb. on the inner knife-edge is equivalent to 1 kw. By having knife-edges on both sides, powers of either positive or negative sign can be measured with either direction of rotation. As the shaft of this machine is necessarily fixed, provision must be made for bringing the motor, *M,* to be tested in line with it. This is done by putting down a cast-iron table, *T,* which can be raised or lowered from a pit by screw gear, *S.* The surface of this table is slotted, and has two slide rails, *R, R,* on it, which can be adjusted to any position by screwed dogs. Any machine to be tested is slid on to the rails, raised to the proper height and brought into line in approximately a quarter of an hour. The balanced generator is provided with a telescopic shaft, *T S,* allowing of a variation of length of about a foot, and on the end of this shaft is fixed an American self-centering jaw-chuck, *C,* taking any shaft up to 2 in. in diameter. The author then describes the connection of the main and shunt terminals of the generator, *G,* with a special switchboard and the electrical arrangement for the machine under test. The mounting of the machine on ball bearings was found not to give sufficient sensitiveness. To increase the sensitiveness recourse was had to the swinging of the generator on knife-edges in a manner similar to that employed in a testing-machine. The original article contains very detailed instructions telling how to use the apparatus, and several test curves taken by it are reproduced.—Lond. *Eng'g,* November 24.

FIG. 5.—DIAGRAM OF TUBE.

Rendering Quartz Fibres Conductors.—BESTELMEYER.—The advantage of rendering a quartz fibre conducting is that in this way the necessity of charging an electrometer needle by contact is avoided. Himstedt for this purpose silvers fibre, while Dolezalek moistens it with a hygroscopic solution. The disadvantage of the first method is that the elasticity is interfered with, while in the second case the apparatus cannot be properly dried. The present author has devised a third method which is free from both objections. He platinizes the fibre by cathode disintegration. He uses a vacuum tube, as shown in Fig. 5, where *K* is a platinum wire serving as a cathode, *A* is an aluminum wire acting as an anode, and holding the quartz fibre, while *P* is a platinum wire which keeps the fibre stretched and also serves as a third electrode for the purpose of ascertaining whether the fibre has become conducting. The author uses a vacuum of 0.1 mm. Hg, a voltage of 1,280, and a current of 1 to 3 milliamperes. The fibre becomes conducting in about 10 minutes, except the ends which are embedded in sealing wax. It is best to silver the sealing wax by chemical means. The fibres so platinized show no elastic after-effect, and their conductivity appears to be permanent.—Lond. *Elec.,* December 1; from *Zeit. f. Instrumentenkunde,* November.

Ground Detectors.—COE.—An article describing the construction and use of various types of ground detectors, and showing in diagrams their connections.—*Am. Elec.,* December.

TELEGRAPHY, TELEPHONY AND SIGNALS.

High-Frequency Currents and Electric Waves.—FLEMING.—An account of the first of the series of Cantor lectures. The author drew particular attention to the fact that the capacity is not alone a function of the form of the body itself, but also depends on the surrounding objects. Although it is possible to calculate the capacity of certain simple forms of bodies, the only accurate method for determining the capacity of complicated bodies or bodies surrounded by other objects is by direct experiment. The capacity of the earth is 800 mfd., and that of a single wire 100 ft. long and 0.1 in. in diameter one-five-thousandth mfd. Mention was then made of the fact that high-frequency currents flow on the surface of the conductor. The impedance offered to high-frequency currents in a metallic wire is very high. A convenient formula for calculating this impedance (R') is the following: $R' = R \pi d \sqrt{n/80}$, in which R = ordinary ohmic resistance, d = thickness of wire, and n = frequency of oscillations. This phenomenon was illustrated by showing that a high-frequency current would jump across an air-gap rather than flow through a small loop of copper wire of small resistance connecting the two spark knobs. The spark resistance increases with the spark length, but at a somewhat irregular rate. The resistance (beyond a certain small air-gap) is smaller for zinc or brass spark knobs than for iron knobs. This must be put down to the lower melting point of zinc, which volatilizes more readily than iron and thus forms a conducting bridge of metallic vapor at a lower temperature. In order to get the equivalent of a long spark, combined with a low spark resistance, a number of spark knobs, separated by a small air-gap from one another, could be arranged side by side.—Lond. *Elec.,* December 1.

MISCELLANEOUS.

Electrotherapeutics.—JONES.—A paper read before the Hunterian Society in which the author sums up the useful therapeutic applications of electricity and their limitations. High-frequency treatment "has already shrunk into its proper small dimensions," and the light bath "is destined to become a more or less ornamental accessory in Turkish bath establishments." A large part of the paper deals with the introduction of drugs into the human body by electrolysis. For instance, to introduce zinc into a certain part of the body, an electrode is moistened with zinc chloride or zinc sulphate and used as anode. The author has obtained in this way good results in the local treatment of rodent ulcer.—Lond. *Elec.,* December 1.

Ventilation and Warming of Theater.—A note on the system of warming and ventilation of the Theater Royal, Drury Lane. There are used four electrically-driven large centrifugal fans, the aggregate weight of which amounts to about 3 tons. They are driven by four motors representing a total capacity of 33 hp. Fresh air, warm or cold, according to requirements, is being continually pumped into the theater by one set of fans, while the other set extracts air from the building.—Lond. *Elec.,* November 24.

Standardization of Incandescent Lamps.—An editorial referring to a report of the sub-committee of the (Brit.) Municipal Association on standardization of carbon-filament incandescent lamps. The report has not yet been made public. It is doubted by the editorial writer whether the standardization of incandescent lamps is really necessary at present or would be advantageous to the electricity supply industry generally. "It is an open question whether the time and energy which would be expended by the lamp manufacturers in modifying their processes so as to enable each lamp to comply with a close specification, would not be better devoted to experimental research in the direction of improving the existing lamp rather than standardizing it in its present form."—Lond. *Elec.,* November 24.

BOOK REVIEWS.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION. Year ending June 30, 1904. Washington: Government Printing Office. 804 pages, illustrated.

As usual with the annual volume issued by the Smithsonian, this report contains many papers of interest to the general reader of science and also to the specialist. This volume contains a full account of the Rumford spectroheliograph of the Yerkes Observatory, which is attached to the 40-in. refractor, and also eighteen plates of results obtained showing the solar disc, faculæ, calcium flocculi, hydrogen flocculi, etc.

For the measurement of radiant energy, a new form of the Langley bolometer was designed for use at the St. Louis Exposition where expert attention would not be available. The arms of the balance could be adjusted to anything between 1/200 to 1/200,000,000 of the relative value of the resistances.

The distinguished secretary, S. P. Langley, contributes an account of experiments made with his aerodrome in the concluding sentence, of which we are told that "There have been no failures as far as the actual test of the flying capacity of the machine is concerned, for it has never been free in the air at all." The failures which were reported in the papers occurred on the launching ways, so that the question of its ability to fly is yet an untried one. To decide this time and money are both necessary.

Other subjects treated in this volume are: "New Methods of Lighting," by A. Berthier; "Electric Welding," by Elihu Thomson; "Discoveries in Photography," by Robert Hunt, with photographs of Niepee, Fox Talbot and Daguerre. The biographical sketches include Sir George Stokes, by Ernest W. Brown; Karl Alfred von Zittel, by Charles Schacert, and Karl Gegenbauer, by Oscar Hertwig.

WIRELESS TELEGRAPHY. Its History, Theory and Practice. By A. Frederick Collins. New York: McGraw Publishing Company. 300 pages, 332 illustrations. Price, $3.00.

Mr. Collins' book is a valuable addition to the literature of wireless telegraphy. Chapters I to VIII, inclusive, are in the main theoretical in their nature, and treat successively of the ether, wave motion, electric waves, disruptive discharge, electric oscillations, oscillators, capacity, inductance, resistance and mutual induction. Chapters IX to XI treat of the different forms of induction coils, interrupters and oscillating-current generators now in use. Chapters XII to XIX take up wireless telegraphy proper and the various forms of transmitters and receivers used in the art. The last chapter describes the different systems of wireless telephony which have been invented up to the present time.

The book is particularly strong on the practical side and there are many excellent and unusual pictures and diagrams of apparatus now in use by the different systems. There are also pictures of the exteriors and interiors of a number of stations.

Chapter I on the ether gives a good description of the supposed nature of that imponderable medium and Chapter II of wave motion in general. In Chapter III there is a description of Herz's classical experiments. Fig. 35 at the end of this chapter shows the lines of electrostatic force radiating from the top of the antenna, but this diagram is incorrect, as the lines of force are distributed along the length of the antenna from the top to the bottom; also, the peculiar figure (Fig. 36) showing a reflection of the electric wave from the more rarefied strata of air, back to the earth, cannot represent the actual state of things. According to the best modern opinions upon the subject, the electromagnetic waves travel outward from the antenna in ever-expanding circles, like the ripples from the point where a stone strikes the surface of a pond. A slight reflection of the waves from the upper rarefied layers of the atmosphere may take place, but probably does not radically change the ripple mode of propagation. The ether ripples probably differ from the water ripples in one important way, namely, that they increase instead of decrease in height as they go outwards. Fig. 35 in Mr. Collins' book is not nearly as satisfactory as Fig. 93 in Vreeland's recent book on the same subject. In this same chapter Mr. Collins also states that "Lebedew and Fleming have produced electric waves so short as to be measured by the ten-millionth part of an inch." The reviewer believes this statement to be incorrect; in fact, he is not aware that electric waves have been produced less than a few centimeters in length.

The chapters on disruptive discharge and on electrical oscillations and oscillators are good. Those on capacity, inductance, resistance and mutual induction are good and embody many things not usually contained in books on wireless telegraphy; as, for instance, that part of the chapter on mutual induction which contains the elementary theory of the induction coil. The chapters on induction coils, interrupters and generators contain many excellent pictures and much useful information.

The chapters enumerated form about half the book. The rest of the book deals with wireless telegraphy proper and contains descriptions of the different systems and much detailed information. The pictures and diagrams are good. No attempt has been made to give a complete mathematical theory of wireless telegraphy, and only a few scattered equations have been given.

LEHRBUCH DER PRAKTISCHEN PHYSIK. By F. Kohlrausch. Berlin: B. G. Teubner. 656 pages, tables and illustrations. Price, 9 marks.

This is the tenth edition of this text-book on physics, which for over twenty-five years has, in its successive issues, been accepted as one of the standard authorities on its subject. Those who were reared on the immediately preceding editions, or have had occasion to consult them frequently, will recognize this latest revision as following closely along the lines of the others.

It does not pretend to be more than a text-book dealing with principles only, but presents an orderly homogenous assemblage of physical laws and facts with occasional efforts at critical handling. As a treatise on physics it is more or less elementary, to be sure, and in his desire to compact the pill of knowledge to the uttermost the author not infrequently sacrifices clearness to terseness. The result is not all that might be desired for a beginner who has not considerable command of the German language, and would conceivably prove embarrassing even to the German student if not supplemented, as it should be, by much junior laboratory and lecture-room work. The almost exclusive employment of the most skeletonized diagrammatic illustrative figures in pursuance of the writer's plan of avoiding "pictures" might be somewhat criticised, although it must be confessed that it is refreshing once in a while to find a volume whose illustrations are not all familiar contributions "by courtesy" and incidentally for the advertising benefit of apparatus makers.

The reviewer has not taken occasion to dig through this present volume page by page to discover what main differences there may be between it and the preceding 1901 edition. The tables have been increased to some extent, now forming a total of sixty-four, all convenient and many valuable; and there is an interesting two or three pages on the determination of constants by the method of least squares. There are doubtless many who would be glad to have such a text-book in shape for ready assimilation by their students, and others who have left their student days behind who might on occasion find it most convenient to be able to pluck it from a shelf for a hasty refresher on some half forgotten subject.

SUBJECT LIST OF WORKS ON ELECTRICITY, MAGNETISM AND ELECTROTECHNICS. Library of the British Patent Office. London: His Majesty's Stationery Office. 286 pages. Price, 8 pence.

This latest edition of the Subject List of the Electrical Library of the British Patent Office enters 2,374 works, including pamphlets and 131 serials, representing a total of 3,792 volumes. That the library can in no respect be considered a complete one is evident from a comparison with the Library of the American Institute of Electrical Engineers, which has 8,996 volumes and 6,737 titles; the latter figure would, moreover, be increased by several thousand if the titles were included of the separate pamphlets in the Wheeler collection.

Checking a few sections of the list to get an indication as to how fully American publications are represented in the collection, we find that under "Pocketbooks, Tables," neither Foster's "Handbook" nor Hering's "Reference Tables" is entered. A reference to Mottelay's "Chronological History of Electricity," which originally appeared in this journal, only indicates the fragment which appeared in London *Engineering*. Only one of the several American telephone journals is entered, and this not the most important. American electric traction periodicals are only represented by the short-lived *Electric Railway Advertiser* of 1890-91 and the *Street Railway News* of 1891. General works on electricity and magnetism dated before 1880 are included under "Static Electricity." The oldest work is one by Boyle, 1675, the next earliest bearing the date 1744;

and the great rarities in old electrical literature are conspicuous by their absence. As the object of the library appears to be primarily for use in connection with researches into invention, this deficiency is perhaps a natural one. Doubtless the criterion applied in purchasing books has been their probable utility in connection with researches by patent office examiners and inventors, and from this standpoint the catalogue should be a useful bibliography.

BOOKS RECEIVED.

CAMS AND THE PRINCIPLE OF THEIR CONSTRUCTION. By George Jepson, New York: D. Van Nostrand Company. 59 pages. 37 illustrations. Price, $1.50 net.

THE PRODUCTION OF ALUMINUM AND ITS INDUSTRIAL USE. By Adolphe Minet. New York: John Wiley & Sons. 266 pages, 57 illustrations. Price, cloth, $2.50.

TELEGRAPHY. A Detailed Exposition of the Telegraph System of the British Post Office. By T. E. Herbert. London: Whittaker & Company. 912 pages, 509 illustrations. Price, $2.60.

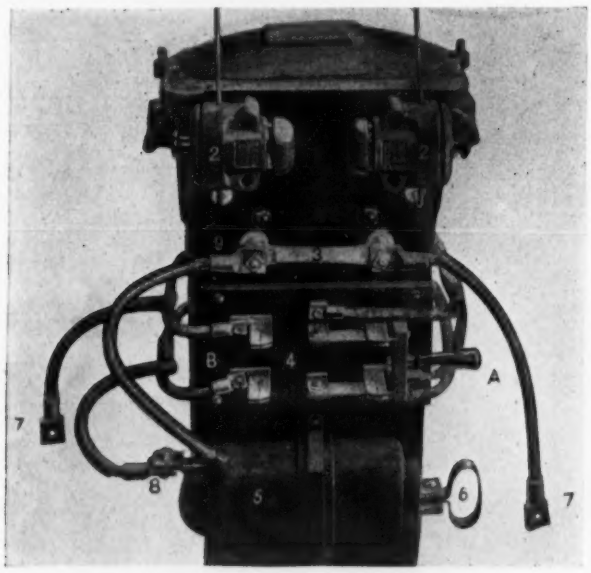
LA SEPARATION ELECTROMAGNETIQUE ET ELECTROSTATIQUE DES MINERAIS. By Desire Korda. Paris: *L'Eclairage Electrique.* 219 pages, 54 illustrations. Price, 6 francs.

DIE MODERNE THEORIE DER PHYSIKALISCHEN ERSCHEINUNGEN. By Augusto Righi. Leipzig: Johann Ambrosius Barth. 152 pages, 17 illustrations. Price, 2.80 marks.

Transformer for Thawing Frozen Water in Pipes.

The illustrations herewith show a thawing transformer recently placed on the market by the Pittsburg Transformer Company, Pittsburg, Pa. This transformer is equipped with primary fuse blocks, a controlling device for adjusting the current, a heat indicator and a large capacity secondary switch. The primary leads of the transformer run through porcelain bushings in the backboard and into the fuse blocks. Within the transformer is a porcelain terminal block, changing the connection of which adapts the transformer to operation on circuits of approximately 1,100 volts or circuits of approximately 2,200 volts.

Four secondary leads issue from the front of the case and pass to



REAR VIEW OF THAWER.

the terminals of the double-pole double-throw switch No. 4. Throwing this switch to the left connects the secondary coils in multiple, so that the transformer delivers 37½ volts and has a capacity of about 800 amperes. Throwing switch to the right puts the secondary coils in series, so that a pressure of 75 volts is obtained, the current capacity being 400 amperes.

The secondary line passes through the choke coil, 5, and from there to the heat indicator, 3. The choke coil plunger is shown at 6. The choke coil consists of several turns of copper rod, and has a laminated iron core, supplied with a handle for pushing in and out, thus altering the choking effect to suit the conditions involved.

The heat indicator is simply a short section of lead pipe connected in series with the low-voltage winding, in the same manner as a fuse, its temperature being a guide as to the heating of the pipe under treatment.

The capacity of the thawer is normally 400 or 800 amperes, as stated above, but currents considerably in excess of these values may be drawn for short periods. It should be remembered that usually the temperature of the air will be below freezing point or even many degrees below zero. Under such conditions a temperature rise in the transformer as high as 100 to 125° C. above the air will still be within the usual working limits.

The intermittent nature of the work is also favorable, and it will frequently be found that 500 to 600 or 1,000 to 1,200 amperes can safely be drawn from the thawer. Snow or ice can also be applied to the cast iron case to assist in cooling when running under extreme loads for considerable periods of time.

While pipes exposed to the air generally burst in freezing, yet it has been found that when they are in the ground very few cases of bursting are met with. It has been observed that but one case in 600 shows rupture under such conditions, due perhaps to the fact that the earth first freezes solidly around the pipe, thus preventing its expansion from internal pressure. This is of the greatest importance, for were it otherwise, electrical thawing would be of small practical use.

It is to be noted that ammeters or voltmeters are valueless for this work and are therefore a needless expense. The operator has no interest in the voltage or the current strength, as long as these are sufficient for the purpose. The heating effect is the important feature, and it is a simple matter to judge this by touching the heat indicator with the hand or with a wet mitten. The most unskilled operator knows when this pipe is hot, although he might be entirely at a loss to know whether he should use 200 amperes or 500 amperes were he dependent upon an ammeter. It is claimed that its simplicity makes this outfit the most practical as well as the cheapest successful device of this kind yet produced.

Vertical Pump Motors.

The Electro-Dynamic Company has recently supplied a number of 50-hp and 100-hp "Inter-pole" motors, shown in the accompanying illustrations, to operate centrifugal pumps, built by the Southwark Foundry & Machine Co. The outfits are used in connection with two Weiss central condensing plants, and pump either to the condensers or cooling racks as desired.

The 50-hp vertical inter-pole motors have a speed variation of 2 to 1 and operate 8-in. pumps. The pumps are of the single inlet pressure balance type and are direct connected to the motors

VERTICAL PUMP MOTORS.

by means of flexible couplings. They are equipped with thrust bearings for the pump shaft and have runners on the top side cover. With this equipment pumping is done direct to the condensers. Each pump has a capacity (normal rating) of 1,700 gallons per minute, and has a starting head of 50 ft., with a regular service of 50 ft,. less head due to vacuum, or an average of 25 ft. The 100-hp motors, also illustrated, have the same speed variations, and the same conditions apply as for the 50-hp motors with the exception that they are connected to 12-in. pumps and have a normal rating of 3,200 gallons per minute. . The total head is 45 ft. continuous.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—The weather conditions favored holiday trade and few of the seasonable goods will remain undisposed of. People had plenty of money and spent it liberally, and the holiday business of this year will hold the record. Retail trade in heavy winter goods still drags, owing to the unseasonably mild weather. Excellent reports are received as to spring business and indicate activity in excess of previous years. Manufacturing is active, iron and steel leading with enormous outputs and record engagements ahead in all crude and manufactured products. Open fall weather still favors building activity, and another big year is indicated by high prices and active demand for material, particularly in lumber. Winter wheat is in good condition. The demand for money is active but collections are reported to be a trifle slow. Cash is moving to the interior. The situation in metals of all kinds is quite unprecedented. During the year 34,000,000 tons of iron ore were sold and shipped, and sales for 1906 aggregate 30,000,000 tons at higher prices. The Steel Corporation is reported to have 7,300,000 tons of material on its books, a gain of 55 per cent over a year ago. Crude steel is scarce. Chicago district mills have their entire 1906 rail output engaged. Prices of pig iron are firm and tend upward. The market for other metals was strong, and copper touched record prices of late years, sales being reported at 19½c. One of the largest metal firms, whose output from its own copper mines and smelting works exceeds 5,000,000 lbs. per annum, has sold the bulk of its estimated output for 1906 at 18¾c. to a syndicate of brass rolling works. This firm is about opening three mines in Mexico, and has contracted for a new smelting plant that will double its output of this year. High prices are stimulating the gatherers of old copper to the utmost. In the old metal trade, copper stock is scanty and fetches 17½@18¼c. for heavy cut and crucible; light and bottom rule at 15¾@16c; machinery composition, 15⅞@16c. Exports of copper through the port of New York from December 1 to 23, inclusive, were 13,000 tons—mainly for account of contracts made six months ago. Orders booked for cars, locomotives and other rolling stock in 1905 largely exceed those of any preceding year. *Bradstreet's* reports 235 business failures during the week ending Dec. 21, against 226 the week previous and 249 the corresponding week last year. The commercial failures so far this year show a large decrease in number and in liabilities, and analysis discloses reason to interpret the figures even more favorably than their face. Manufacturers' failures show a decrease of both number and amount, the total, $46,582,475, being some nine million dollars below 1904. The unsuccessful traders report liabilities of $52,080,400, or fourteen millions below 1904. Brokers and transporters also report a decrease of liabilities by twenty-one millions. In other words, all three great classes make returns which are absolutely and relatively good.

THE COPPER SITUATION. The *Copper Gossip*, of the National Conduit & Cable Company, has the following with regard to the copper situation: "The market for copper is exceedingly strong, and for sometime past has been growing stronger daily. On the positive evidence of the scarcity of available copper for nearby delivery a sharp upward movement set in about three weeks ago. Between November 25 and December 15, electrolytic wire bars advanced from 17½ to 19 cents. The present copper situation is a phenomenal one, and the strong position of the metal cannot be gainsaid. Most of the producers have sold a large proportion of their output for months ahead, and this fact alone is one of the best evidences of the confidence felt in the outlook. Consumption has increased steadily on the rising market, and demand in 1905 surpassed anything previously reached. Domestic wire drawers and melters of copper generally have had an unprecedented volume of orders, and there is no noticeable curtailment in business on the current high prices. The market is obviously strong on legitimate business conditions of a highly favorable nature, and the prospect for a continuance of extremely prosperous times is remarkably good. It is conceded by leading authorities, who have exceptional opportunities to judge of the actual merits of the copper situation, that intrinsic conditions warrant the expectation of market strength for months to come. The trade is on a wonderfully sound basis, and the heavy tonnage required to meet the home and foreign demand justifies the strong tone. Manufacturing plants are rushed with orders, and business already secured insures very active operations for a good part of 1906. Cash copper is very scarce, and the small lots procurable command a premium. A feature of the situation is that consumption goes right on at tremendous rate. Prices have reached a high level, and the tendency continues upward as offerings become more limited. Natural causes thus far have been favorable to stability, and it is to be hoped that conditions will not become so acute as to send prices very much higher. Copper at 25 cents a pound would probably prove too high to maintain all round satisfactory conditions."

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. are furnishing equipments for an unusually large number of industrial power plants of a diversified character. Among recent shipments are included one to the Lehigh-Northampton Gas & Electric Company, Catasauqua, Pa., of a 150-kw, 350-volt, three-wire engine type generator and two auto transformers; to the Keystone Coal & Coke Company, Keystone, W. Va., one 350-kw, 550-volt, engine-type generator and a 60-kw, two-phase, 1,100-volt alternator; to the Granite City Hospital, Granite City, Ill., a 35-kw, 250-volt, type S engine type generator, and many others could be mentioned. Owing to the magnitude of the works of the Westinghouse Electric & Manufacturing Company a great many people have received an erroneous impression that the product of this company consisted principally of only the larger types of electrical apparatus, especially so with reference to electrical generating units. The aggregate business of this company, however, in the smaller units far exceeds that of the larger and special types. They manufacture every kind of electrical apparatus for either light or heavy work, and their instruments for measuring electrical energy equal in delicate construction the works of the better class of modern watches. These instruments are recognized standards in their field.

THE NEW YORK, NEW HAVEN & HARTFORD LOCOMOTIVES.—During the past week the first of the twenty-five Westinghouse single-phase electric locomotives ordered by the New York, New Haven & Hartford Railroad for operation on its lines between Woodland and the Grand Central Station in New York City, was received from the Baldwin Locomotive Works, Philadelphia, by the Westinghouse Electric & Manufacturing Co. at its works at East Pittsburg. The Baldwin Co., working jointly with the Westinghouse Co., constructs the locomotives and the Westinghouse Co. provides the electrical equipments. Each locomotive is to be equipped with four Westinghouse single-phase railway motors of the straight series gearless type and also with the unit switch system of multiple control. It is expected that this first locomotive will be ready to run by the middle of January, 1906.

FEED WATER REGULATOR.—That the feed water regulator has become a necessity in modern boiler plants is demonstrated by the recent sales reported by the Williams Gauge Co., of Pittsburg, Pa. Within the last four weeks it has sold equipment for 12,500 hp to the Great Northern Paper Co., 5,000 hp to the National Tube Co., 4,500 hp to the Lehigh Valley R. R., 2,000 hp to the New York Central R. R., 2,500 hp to the Holyoke Street Ry., 4,000 hp to the Pressed Steel Car Co., 2,000 hp to the Buffalo & Susquehanna Coal & Coke Co., 2,500 hp to the B. Altman Co., etc., etc. The entire equipment furnished by the Williams Gauge Co. to date will aggregate 4,100,000 horse power. In some instances these regulators have been in use for upwards of six years without noticeable cost of repairs. Its makers claim that it will pay for itself from two to three times annually in fuel saved and increased boiler efficiency.

SOUTH CAROLINA POWER.—A Charlotte special says the Southern Power Company, capitalized at $7,000,000, has purchased the water power at Ninety Islands on the Broad River in South Carolina, and will proceed to expend $1,000,000 on a 12,000 hp plant. The Southern Power Company is said to control water capable of developing 2,000,000 hp. Dr. W. Gill Wylie, of New York, is president, and J. B. Duke is vice-president of the company.

ELECTRIC AUTOMOBILES.—The Babcock Electric Carriage Co., of Buffalo, N. Y., has purchased the Buffalo Electric Carriage Co., and with increased capital will increase the yearly output to 500 vehicles. F. A. Babcock is president; F. L. Bapst is vice-president, and E. R. Whitney secretary and treasurer.

APPARATUS FOR BOHEMIA.—Mr. F. Ludikar, Jurusalemska ulice, 14, Prague, Bohemia, Austrian Empire, commission agent and merchant in general electrical supplies, desires to communicate with firms manufacturing electrical specialties for power, light, heat, etc.

CURTIS TURBINES.—The General Electric Company is reported to have sold 504 Curtis turbines and to have shipped 315, large and small, up to the middle of December.

CHICAGO PNEUMATIC DRILL.—President Duntley, of the Chicago Pneumatic Tool Co., says: "We are now doing easily 90 per cent of the pneumatic tool business of the world. One-third of our business is done by our foreign companies. The outlook here and abroad is such that I favor an increase in our dividend rate from 4 to 6 per cent. We made a mistake at the beginning in paying 8 per cent. We had to come down to 7 per cent and then to nothing. Later we paid 1 per cent quarterly. This takes a little more than $20,000 per month, which deducted from our surplus earned in October, would leave us a surplus of about $37,000 for that month. October was one of our best months, but not conspicuously so. November was at least as good and indications point to a steady increase month by month without a corresponding increase in operating expenses. We shall continue our policy of charging liberally to depreciation, which item in October was nearly $11,500, and of reducing prices as our business expands. Our foreign policy is to make the rougher grades abroad, leaving the home factories free for work on the finer grades which can be made more cheaply here. In England we make one drill. Here we make twenty-five sizes. In Berlin we also make some drills. Next year we may make compressors in Europe. Foreign governments and shipyards are using our drills and riveters and hammers extensively. Just before I left the Riveters' Union in England accepted a 30 per cent reduction in wages based on the use of our tools. We are now bringing out a line of electric tools, which will create a new industry and a new market that will not infringe on the market for air drills, but supplement it. We have a 40-lb. machine you can attach to the electric light and with it drill a 2½-inch hole in iron or steel. This will be used for the interior work on buildings, drilling in marble and so on. We are selling our goods 40 per cent cheaper than we did four years ago and making more money out of the business than we did then."

THE SOUTHERN POWER COMPANY.—The purchase by the Southern Power Company of an important water power on the Broad River, in South Carolina, makes a total of ten falls now owned by the company. By the time these are all developed they will provide some 150,000 hp which will be distributed to cotton mills throughout the Piedmont region of North and South Carolina. By the acquisition of the stock of the Catawba Power Company, the new company now owns a water power at Charlotte, N. C., which is delivering about 10,000 hp to Charlotte and other towns. Nine of the ten falls are on the Catawba, aggregating about 400 feet of fall and expected to produce from 100,000 to 150,000 primary horse-power. On the Broad River the fall recently acquired is 72 feet. One of the largest plants projected is at the Great Falls on the Catawba, where the company owns a fall of 175 feet. There will be three separate developments and one of them is expected to deliver 30,000 hp by the end of 1906. The Southern Power Company is capitalized at $7,500,000, of which $2,500,000 is preferred, and has issued $2,000,000 preferred stock and $4,000,000 common. Bonds of $5,000,000 have been authorized for construction work, but more have been issued.

GREAT EASTERN TELEPHONE.—Controller Grout began an investigation last week of the Great Eastern Telephone Company, which has announced that it will shortly begin laying conduits, wiring buildings and installing instruments in all the boroughs of New York City. The officers of the Great Eastern Company declare they will do this under the franchise granted in 1883 to the Electric Lines Company, which is now owned by the Great Eastern Company. Inquiry shows that no application has been made by the company for permits to begin the installation of the system. In 1892 the Supreme Court of the United States rendered a decision which was taken to settle the right of the Electric Lines Company to construct these lines under the streets of New York City, and the Controller intends to test the right of the company to begin operations without going before the Board of Estimate to secure a franchise in the regular way. The officers of the company are D. A. Reynolds, president; J. V. V. Olcott, vice-president; Eugene H. Bock, secretary, and W. M. Reynolds, treasurer.

ELECTRICALLY OPERATED VALVES.—An order for 149 electrically operated valves, for the Cincinnati filtration plant, has been received by the Fairbanks Company, Elm and Broome Streets, New York City, and the valves are being manufactured by the Pratt & Cady Company, Hartford, Conn. They will be installed in 29 chambers and electrically operated from the floor above. There will be nine valves in the head chamber and five in each of the others. They will be geared to the floor stand on which is mounted the motor. The valves will be controlled from a distant point, and there will also be a switchboard in each chamber on which will be mounted the controlling device to open and close the valves, which will be designed to take care of overload and underload at any point. The motors will be Crocker-Wheeler and the controlling devices will be manufactured by the Cutler-Hammer Manufacturing Company.

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph instrument statement for the month of November and since December 31 last, compares as follows:

	1905.	1904.	1903.	1902.
Month of November:				
Gross output	183,470	103,922	96,963	93,487
Returned	49,075	39,934	32,297	36,838
Net output	134,395	63,988	64,666	56,649
Since December 31:				
Gross output	1,677,800	1,094,291	1,020,941	994,422
Returned	566,553	465,631	441,013	420,682
Net output	1,111,242	628,660	579,928	573,740
Total outstanding	5,591,811	4,408,177	3,730,248	3,099,346

RECENT STURTEVANT ORDERS.—The new machine and smith shops of the Pennsylvania Railroad Company, Hollidaysburg, Pa., are to be heated and ventilated by apparatus furnished by the B. F. Sturtevant Company, Boston, Mass. The fan is to be electrically driven by a Sturtevant motor. W. A. Choate Manufacturing Company, Wilmington, Vt., is installing a complete heating and dry kiln apparatus furnished by the Sturtevant Company. The machine room of the Piermont Paper Company, Piermont, N. Y., containing over half a million cubic feet of space, is to be ventilated by apparatus furnished by B. F. Sturtevant Company.

BLACK RIVER, WIS., POWER.—At Lacrosse, Wis., the Lacrosse Hydro-Electric Light & Power Company has been incorporated with a capital stock of $1,000,000, to put a water power plant at Mormon Riffles, near Black River Falls, on Black River, with a minimum of 12,000 horse power. Plans call for the immediate expenditure of $750,000 and a further outlay of $500,000. Current will be transmitted to Lacrosse, 55 miles, and to Winona and to other cities and towns within a radius of 100 miles. Col. Orlando Holway, E. G. Boynton and Roy Bingham, all of Lacrosse, are among those interested in the development.

VEHICLE EQUIPMENT CONTRACT.—The board of contract of Rochester, N. Y., has let the contract for the two electric patrol wagons to take the place of the present horse wagons. The contract for the two wagons and necessary batteries was given to the Vehicle Equipment Company of Long Island City for $5,630. It is specified in the contract that the city may order 2,000 pound wagons in place of the 1,000 pound wagons bid on if it wants to. The extra cost will not be over $450.

BIDS FOR NAVY SUPPLIES.—Bids will be received until Jan. 2 at the Bureau of Supplies and Accounts, Navy Department, Washington, to furnish at the navy yards at Boston, Mass.; New York, N. Y.; League Island, Pa.; Washington, D. C., and Norfolk, Va., supplies as follows: Panel boards, cable, conduit and fittings, electrical supplies, incandescent lamps, testing generators, volt-meters, electrical wire, etc. Address H. T. B. Harris, Paymaster-General, U. S. N.

Financial Intelligence.

THE WEEK IN WALL STREET.—News of banking troubles in Chicago early in the week caused a sharp break in the stock market, from which, however, recovery was sharp, and further aggressive bullish manipulation in various specialties was afterwards witnessed. The most serious break of the early-week occurred in Amalgamated Copper and other copper mining shares, that group having been unduly bulled of late, so that there was an extended weak long account open in such securities. On Friday the market found additional material for active bullishness in the reports of the closing of negotiations for the sale of the controlling interest in the Metropolitan Street Railway to the Interborough Rapid Transit Company. Local traction stocks became active and advanced sharply on the report of the deal. This, of course, means that the Interborough Rapid Transit Company will control the entire traction situation in Manhattan and Bronx, and it is naturally assumed that this is the first important step toward the still more comprehensive consolidation of the public utility properties in Greater New York so long expected. Metropolitan Street Railway closed with a net gain of 7½ points, at 127½, the range of prices being between 119⅛ and 130½. The number of shares sold was 284,500. Interborough Rapid Transit closed at 237, which is an advance of 20 points. This stock at one time was quoted at 240⅜, and the lowest figure of the week was 218. Brooklyn Rapid Transit did not show any effect of the New York deal, although there was a good business done. This stock closed at 89⅛, which is a net decline of 1⅛ points. Allis-Chalmers common closed at 22, a net gain of ⅜, and the closing price of preferred was 62. General Electric made a gain of 1¾, closing at 176¾, and

Westinghouse common advanced 1 point, closing at 176; preferred closed at 190. Western Union advanced 1⅜ closing at 92¾, ex-div. American Telephone & Telegraph gained 3¾ points, the closing quotation being 137¼. Following are are closing quotations of Dec. 26:

NEW YORK

	Dec. 19	Dec. 26		Dec. 19	Dec. 26
Allis-Chalmers Co	21⅛	21⅝	General Electric	174	177
Allis-Chalmers Co. pfd	61	61	Hudson River Tel.	...	...
American Dist. Tel.	37	37	Interborough Rap. Tran.	217¼	236⅛
American Locomotive	68	70¼	Mackay Cos.	54⅝	59⅛
American Locomotive pfd.	116	117⅝	Mackay Cos. pfd.	72	73¼
American Tel. & Cable	87	89	Marconi Tel.	...	...
American Tel. & Tel.	134	139¼	Metropolitan St. Ry.	120⅞	126⅛
Brooklyn Rapid Transit	88	89	N. Y. & N. J. Tel.	...	...
Electric Boat	28	28	Western Union Tel.	93¾	92⅛
Electric Boat pfd.	70	70	Westinghouse com.	173	172
Electric Vehicle	12	15	Westinghouse pfd.	..	...
Electric Vehicle pfd.	15	20			

BOSTON

	Dec. 19	Dec. 26		Dec. 19	Dec. 26
American Tel. & Tel.	136¼	140	Mass. Elec. Ry. pfd.	58	59
Cumberland Telephone	...	...	Mexican Telephone	...	3¼
Edison Elec. Illum.	...	240	New England Telephone	131⅛	131¼
General Electric	...	...	Western Tel. & Tel.	..	...
Mass. Elec. Ry.	...	15	Western Tel. & Tel. pfd.	..	91¼

PHILADELPHIA

	Dec. 19	Dec. 26		Dec. 19	Dec. 26
American Railways	52	52	Phila. Electric	8⅜	8⅝
Elec. Co. of America	11	11	Phila. Rapid Trans.	30¼	31
Elec. Storage Battery	81¼	80	Phila. Traction	100⅛	...
Elec. Storage Battery pfd.	..	...			

CHICAGO

	Dec. 19	Dec. 26		Dec. 19	Dec. 26
Chicago City Ry.	197¼	197	National Carbon	76	79
Chicago Edison	...	...	National Carbon pfd.	*120	116¼
Chicago Subway	...	...	Union Traction	..	...
Chicago Tel. Co	...	...	Union Traction pfd.	..	...
Metropolitan Elev. com.	26⅛	26⅛			

* Asked.

MASSACHUSETTS ELECTRIC REPORT.—The pamphlet report of the Massachusetts Electric Companies for the fiscal year ending September 30 makes a materially better showing than for the previous twelve months. The consolidated income account of the controlled railway and electric light companies follows:

	1905.	1904.	Increase.
Gross earnings	$6,734,128	$6,380,863	$353,265
Operating expenses	4,456,303	4,479,520	*23,217
Net earnings	$2,277,825	$1,901,343	$376,482
Interest, rent and taxes	1,543,514	1,462,626	80,888
Net dividend increase	$734,311	$438,717	$295,594
Dividend	372,448	466,003	*93,555
Surplus	$361,863	def. $27,286	$389,149

* Decrease.

The profit and loss statement of the Massachusetts Electric Companies holdings company compares with the previous year as follows:

	1905.	1904.	Decrease.
Dividends stocks owned	$372,540	$466,016	$93,476
Interest received	77,030	105,181	28,151
Total income	$449,570	$571,197	$121,627
Total expenses	17,170	1[illegible],222	*1,948
Net income	$432,400	$555,976	$123,575
Charges	127,400	121,500	*5,900
Balance	$305,000	$434,475	$129,475
Dividends	.....	616,722	616,722
Surplus	$305,000	def. $182,247	*$122,753
Discounted coupon notes	157,500	.....	*157,500
Balance surplus	$147,500	def. $182,247	*$329,747

* Increase.

In his report to the stockholders President Gordon Abbott says: "The usual amount of reconstruction determined by the Railroad Commissioners during the past year necessitated a charge of $311,970 to the profit and loss account of the operating companies. The remaining surplus permitted dividends of only 2 per cent for the year, excepting that in the Hyde Park Electric Light Co., which earned and paid 8 per cent. These dividends were paid into the treasury of the Massachusetts Electric Companies, but after charging off the discount on the coupon notes your trustees have thought it wiser not to declare any dividend on the preferred shares in view of the work still to be done on the properties."

RAILWAYS COMPANY GENERAL.—The Michigan Traction Company securities held by the Railways Company General, of Philadelphia, have been sold, the amount being put at $349,000. The Michigan Traction Company is one of the six companies controlled by the Railways Company General, and is a property which the company has spent several years in improving. The sale made at the Railways Company General places in its treasury, it is stated, cash and assets greater than the market price of its entire capital stock, leaving it five other companies to represent a handsome surplus. The Michigan Traction Company's lines extend from Kalamazoo to Battle Creek, a distance of about 27 miles, and with city lines has a total mileage of 54 miles. The purchase was made in behalf of the same interests which control the Jackson and Battle Creek road, which extends from Battle Creek eastward, a distance of 45 miles toward Detroit. The Jackson & Battle Creek road is believed to have made arrangements with the Detroit, Ypsilanti & Jackson running eastward from Jackson to Detroit, a distance of 105 miles, and connecting there with the Detroit United. In addition to the combination of these three lines, an extension westward from Kalamazoo to Grand Haven on Lake Michigan has been planned, giving finally a through rail and electric route from Detroit to Chicago.

BOSTON ELEVATED.—The growth of electric traction is shown by the figures of the Boston Elevated Railway Co. for the year ended September 30, 1905. The income account and traffic statistics compare as follows:

	1905.	1904.	1903.	1902.
Gross	$12,689,676	$12,391,353	$11,959,514	$11,321,036
Expenses	8,617,653	8,631,553	8,259,860	7,862,572
Net	$4,072,023	$3,759,800	$3,699,654	$3,458,458
Other income	51,893	45,240	59,856	....
Total income	$4,123,916	$3,805,040	$3,759,510	$3,458,485
Charges	3,288,831	2,975,268	2,932,556	2,836,560
Surplus	$835,085	$829,772	$826,954	$621,898
Dividends	798,000	798,000	798,000	600,000
Surplus	$37,085	$31,772	$28,954	$21,898
Rev. miles run	48,069,404	48,317,881	47,476,702	45,772,836
Rev. pass.	246,941,776	241,681,945	233,563,578	222,484,811

The charges above of $3,288,831 are made up of the following items: Interest, $779,757; taxes, $1,047,333; rentals, $1,233,199; subway rentals, $228,540; total, $3,288,831.

PORTLAND TROLLEY BONDS.—Redmond & Company are offering at 100 and accrued interest the unsold balance of an issue of $5,982,000 of the first and refunding mortgage 5 per cent sinking fund gold bonds of the Portland Railway Company. These bonds are a mortgage on the entire property and franchises of the Portland Railway Company, which owns practically all the electric railways in Portland, Oregon. The franchises under which the greater part of the system is operated run beyond 1930, when the bonds mature. The profits of the company show increases year by year, and including the interest on the present issue the net earnings for this year will be nearly twice the interest on the entire funded debt. The gross earnings for 1905 are $1,834,195.

INTERNATIONAL NICKEL.—The earnings for the current year have been in excess of the year preceding, and the payment of dividends on the preferred, based on current earnings, would leave a substantial surplus. The net earnings of the corporation and the surplus over the last three years follow:

	1905.	1904.	1903.
Net earnings	$1,285,715	$936,471	$1,090,401
Surplus	668,094	341,102	559,149

A. Monell, formerly metallurgist of the Carnegie Steel Company, is president of the International Nickel Company. The preferred stock is a 6 per cent non-cumulative issue.

SYRACUSE TROLLEY MORTGAGE.—The New York State Railroad Commission has approved the application of the Syracuse & South Bay Railway Company for the authorization of a $1,000,000 mortgage and an increase of its capital stock to $1,000,000. The commission authorized the issue of $750,000 in bonds against the mortgage, but ordered the company to make further application before issuing the $250,000 remaining.

WALTHAM TROLLEY BONDS.—The Massachusetts Railroad Commissioners have authorized the Waltham Street Railway Co. to issue $100,000 5 per cent 20-year bonds to pay for certain floating indebtedness incurred in the construction and equipment of the railway and in the purchase of property necessary for its operation.

JAMAICA, WEST INDIES. It is stated that Montreal capitalists have formed the Jamaica Light & Power Co., to operate the lighting plant of the city of Kingston in Jamaica. The lighting and trolley systems there are Thomson-Houston.

TOLEDO RAILWAYS & LIGHT shows for eleven months a surplus gain of $98,000 over the same period of 1904, and the earnings on the $11,000,000 of stock for the year are expected to reach not far short of 4 per cent.

TELEGRAPH EARNINGS.—The statement of the Central & South American Telegraph Company for the December quarter shows gross of $350,000 and net $246,000; the surplus being $130,616. All are large gains over 1904.

DETROIT UNITED RAILWAY shows a gross for eleven months of $4,685,844, an increase over last year of $531,898; while the increase in the net is $257,399.

DEALS IN IOWA.—The *American Gas Light Journal* notes the following: "An event of much interest in business circles at Waterloo and Dubuque was consummated at the Commercial National Bank, at Waterloo, recently. This was the conclusion of a contract by the terms of which George McLean, of Dubuque, president of the corporation, sold to Rufus C. Dawes, of Chicago, the entire capital stock, both common and preferred, of the Waterloo and Cedar Falls Gas and Electric Light Company. The company's authorized capital stock is $575,000, and the bonds $150,000, making a total of $725,000. The buyers paid the purchase price and interest in cash. The corporation owns the gas and electric light plants of Waterloo, the electric transmission line between Waterloo and Cedar Falls, the electric system of Cedar Falls and the new gas works at Cedar Falls, now approaching completion. Mr. McLean became interested in Waterloo 5 years ago. The city then had the poorest lighting plants, both gas and electric, of any place of its size in the country. To-day it has the best. He first acquired the franchise of the Citizens Light, Heat and Power Company, which was about to expire because the holders, about 15 of Waterloo's most prominent and wealthy citizens had not used it. Next he bought a controlling interest in the Waterloo Gas and Electric Light Company, then supplying the city with both gas and electricity. A new corporation, including the leading business men of Waterloo, and Mr. McLean and Mr. B. F. Harriman, of Dubuque, was then formed, which took over these properties. A new franchise for 25 years was obtained for the new company, a new site purchased, and new and modern plants, both gas and electric, were constructed. The electric property at Cedar Falls was acquired, the generating station there scrapped and current supplied to Cedar Falls from the Waterloo station. Mr. Dawes, the purchaser of the establishments named, is the head of a syndicate which owns a dozen or more gas properties in different parts of the country. It is understood that several capitalists are interested with him in the Waterloo property, including one of his brothers, Charles G. Dawes, president of the Central Trust Company of Chicago, and former Comptroller of the Currency; James B. Forgan, president of the First National Bank of Chicago; I. C. Elston, banker, of Crawfordsville, Ind., and I. C. Elston, Jr., president of the East St. Louis Gas Light Company. The last named gentleman will make Waterloo his home and will succeed Mr. McLean as president of the company."

DIVIDENDS.—The National Carbon Company have declared a semi-annual dividend of 2 per cent on the common stock, payable January 15. This is an increase of ½ of 1 per cent, the June dividend having been 1½ per cent. Directors of American Telephone & Telegraph Company have declared the regular quarterly dividend of 1½ per cent and an extra dividend of ¾ per cent. This is the usual rate that is declared in June and December, while 1½ per cent is usually declared in March and September. Directors of the Westinghouse Electric & Manufacturing Company have declared the regular quarterly dividend of 2 per cent on the capital stock, payable January 17. assenting stocks. The regular quarterly dividend of 1¾ per cent will be paid on Metropolitan Street Railway stock January 15. Directors of American Locomotive have declared the regular quarterly dividend of 1¾ per cent on the preferred stock. Directors of the New York Air Brake Company have declared the regular quarterly dividend of 2 per cent on the capital stock, payable January 17. International Nickel Company has declared its first dividend of 1½ per cent on the preferred stock. The preferred stock is entitled to 6 per cent annual dividends. The Electric Storage Battery Company has declared a dividend of 1¼ per cent on both the preferred and common stock, payable January 2. The Hall Signal Company has declared a quarterly dividend of 1½ per cent on the common stock, payable January 2. Directors of the Union Switch & Signal Company have declared the regular quarterly dividend of 2 per cent on the common stock and 2½ per cent on the preferred stock, payable January 10. The Cleveland Electric Railway Company has increased the dividend rate from 4 to 5 per cent per annum. A quarterly dividend of 1¼ per cent is payable January 5. Directors of the Bell Telephone Company of Philadelphia have declared the regular quarterly dividend of 1½ per cent, payable January 15. The directors of the New Orleans Railway & Light Company have declared a quarterly dividend of 1¼ per cent on the preferred stock, payable January 15. This is the first dividend since the reorganization was effected. Directors of the Detroit United Railway Company have declared the regular quarterly dividend of 1¼ per cent on the capital stock, payable February 1. The directors of the Central & South American Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable January 9.

BELL TELEPHONE BONDS.—As to the new convertible bonds of the American Telephone & Telegraph Company, it may be noted that the bonds are to be convertible in not less than two years and not more than twelve years after the date of issue. However, this point is not fixed, and the bonds may just as well be convertible after three years and not longer than ten years, or during some other period between two years and twelve years from date of issue, those being merely the limits set by law in case of convertible bonds. As yet no statement has been made as to when any of these bonds will be issued, regarding the rate of interest that they will bear, nor the rate of conversion. These are details which are yet to be settled. President Fish stated at the meeting that the directors have done nothing definite in this direction as yet. When these bonds are issued, if they are, the stockholders may, or may not, receive rights in connection with the issue. The impression gathered from President Fish's remarks at the meeting was rather to the effect that there would be no rights, at any rates in the near future, in connection with the issue. However, he made no definite statement or promise in regard to the matter. The danger of offering the bonds to the stockholders before offering them to the public in general would lie in the fact that if the stockkholders did not take their allotments the bonds would receive a severe setback in the market.

ADVANCE IN MACKAYS.—According to the *Wall Street Journal,* the sharp advance in Mackay Companies common in the outside market is due to a prospective increase in the common dividend. A 1 per cent semi-annual dividend was declared on the common this month and no increase can be looked for in the near future. However, interests in close touch with the corporation say the stock is likely to be placed on a higher basis about the middle of next year. The first semi-annual dividend of 1 per cent was paid on the common in January of this year. With the stock selling in the neighborhood of 56, the income to the investor is less than 4 per cent. The authorized capital of the Mackay Companies is $50,000,000 preferred and $50,000,000 common, of which there are outstanding $35,968,700 preferred and $41,380,400 common. To pay these dividends about $2,270,000 are required. The earnings of the Mackay Company properties are showing substantial gains, due to a large extent to the additional cables.

AMERICAN TEL. & TEL.—The stockholders of the American Telephone & Telegraph Co. have authorized $150,000,000 of convertible bonds. The bonds will be issued from time to time at the discretion of the directors, to provide funds required for the extension of the company's business. It is also possible that, according to condition, some other security may be used for this purpose, but a convertible bond is regarded as a useful form of security for use at any time. About $25,000,000 a year is required by the American Telephone & Telegraph Co. for some years to come. At the special meeting of the stockholders of American Telephone & Telegraph Co. 1,438,136 shares were voted, of which 1,234,613 were cast in favor of the proposition to authorize $150,000,000 convertible bonds; 3,523 votes were cast against it.

WESTINGHOUSE ELECTRIC IN ENGLAND.—The report of the British Westinghouse Electric & Mfg. Co. just issued for the year ending July 31, 1905, shows a gross profit of £113,409. After providing for debenture and loan interest, depreciation and some special expenditure, a loss of £15,407 is shown after deducting the balance of £2,809 brought forward from the previous year. The special expenditures above referred to are £45,549 under the Mersey Railway contract; £5,340 exhibition and sundry, and £25,000 excess cost and experimental outlay on new types of apparatus. Mr. Newcomb Carlton has been added to the board and is now in England.

POWER IN CALIFORNIA.—A special dispatch from San Francisco of December 22 has the following with regard to news already referred to in these columns: "An enterprise for supplying electric power throughout the counties of central California has just been set on foot by the issuance of bonds in Boston and New York. The project, which was proposed by local men, has been taken up by Eastern capitalists, and the construction of a power house is already under way. The company is known as the Stanislaus Electric Power Company, and a New York trust company is trustee of the bond issue, which amounts to $10,000,000."

PHILADELPHIA BELL STOCK.—The directors of the Bell Telephone Company of Philadelphia, at a meeting on December 21, decided to recommend to the stockholders that the capital stock of the company be increased from $16,000,000 to $30,000,000. The stockholders will vote on the proposition on February 20. If the recommendation is approved the new stock will be offered to stockholders from time to time in proportion to their holdings in such amounts as the requirements of the business may demand.

WESTINGHOUSE MACHINE STOCK.—At a meeting of the stockholders of the Westinghouse Machine Company last week, it was decided to increase the capital stock from $5,000,000 to $10,000,000.

SOUTHERN BELL.—The Southern Bell Telephone & Telegraph Company has filed with the Secretary of State in Albany a certificate of increase of capital stock from $1,000,000 to $30,000,000.

General News of the Week

The Telephone.

MONTGOMERY, ALA.—The incorporation of the Fayette Telephone Company, with a capital stock of $2,000, is recorded. The incorporators are W. J., V. M. and F. T. Johnson.

BLACK SPRINGS, ARK.—The Black Springs Telephone Company has been granted articles of incorporation. The capital stock is $3,000, of which $1,000 is subscribed. The company is organized for the purpose of operating telephone lines in Montgomery and adjoining counties.

NEW BRITAIN, CONN.—The Farmington Valley Telephone Company has increased its capital stock from $27,000 to $54,000.

TAMPA, FLA.—A merger of local telephone exchanges has been announced whereby the Southern Bell Company abandons the local field, its plant, equipment, business and franchises being acquired by the Peninsular Telephone Company, the independent company which has been operating here several years. The consideration has not been made public. The Bell Company will retain its long-distance toll line privileges and proposes to establish connection at once between Tampa and Jacksonville. The Peninsular Company has petitioned the City Council to repeal the clause in its franchise fixing the maximum rates so as to allow it to raise rates, claiming that present rates are not sufficient to pay the cost of operating.

THOMSEN, GA.—At a meeting of the city council the local telephone system was leased from the stockholders with the privilege of buying the property later. The capital stock of the company will be increased, and many needed changes will be inaugurated. The action of the council was in line with the views of the present administration, that all public utilities should be owned by the town.

SAND POINT, IDAHO.—Nathan Powell, of Saglo; T. P. Craig, Geo. Matthews and William McKinney are promoting a company to install a telephone system between Sagle and Sand Point.

TAYLORVILLE, ILL.—The Christian County Telephone Company has increased its capital stock from $10,000 to $250,000.

QUINCY, ILL.—F. J. Penick, J. R. Pearce and S. F. Scott have applied to the Secretary of State for a license to organize a company to be known as the Quincy Long Distance Telephone Company. The object for which the company is being organized is to build long-distance telephone lines to be connected with and used in conjunction with the Quincy Home Telephone Company. The capital stock of the preliminary organization is fixed at $2,000.

CHICAGO, ILL.—Mayor Dunne has started a movement looking toward cheaper telephone rates for Chicago. He has had a conference with vice-president and general manager A. S. Hibbard of the Chicago Telephone Company, and informed him what was in his mind and asked if the company was willing to meet the proposition half way. Mr. Hibbard said he would see the officials of the company and give the mayor an answer.

HYMERA, IND.—An ordinance has been passed granting the Hymera Telephone Company a franchise in the town of Hymera, Sullivan County.

DANA, IND.—The Indiana Telephone Company has been incorporated. The capital stock is $50,000. The incorporators are: George W. Hughes, John L. Harney and J. H. Davis.

INDIANAPOLIS, IND.—At a meeting of the directors of the New Long Distance Telephone Company, it was decided to pay the regular quarterly dividend of 1 per cent. on January 10, 1906, instead of January 1, as heretofore.

NORTH VERNON, IND.—As a result of an attempt by the Independent Telephone Company to raise rates on telephones, a movement has been started that may result in giving the Bell Telephone Company the same kind of franchise and an equal chance for the business. Originally the telephone system in this county was owned by private individuals and a 25-year franchise was secured with the maximum rate of $1 a month with $2 for business houses. Since the property was taken over by the Independent Company, improvements have been added, and the company now claims to be operating at a loss, and has petitioned the Council to amend the franchise so that an increase may be possible. There is a strong probability that the Council will grant the request, in which event the Bell company will make a fight for equal privileges.

INDIANAPOLIS, IND.—The Queen City Home Telephone Company, capitalized at $10,000, has been incorporated. The incorporators are Harry B. Gates, of Indianapolis; George W. Beers, of Ft. Wayne, and other Indiana men. The Supreme Court of Ohio recently declared the former organization of this company invalid because it had not strictly complied with the incorporation laws of Ohio. The reorganization is to overcome this. The company proposes to ask the new city council of Cincinnati for a franchise, the old council having denied the same to the old company.

INDIANAPOLIS, IND.—A meeting of the directors of the Indianapolis Telephone Company was held last week to discuss the plans of reorganizing the operating methods of the company. President Stifel, of St. Louis; J. S. Brailey, Jr., of Toledo, and C. E. Stinson, local manager, were among those present.

FT. WAYNE, IND.—An arrangement is said to be pending between the Home Telephone Company and the National, whereby the former will take over the latter. The capital stock of each company is $250,000. The National Company owns a stretch of toll lines, with exchanges at Auburn and New Haven, and has been doing a good business.

COLUMBUS, IND.—The Central Union Telephone Company has approved plans for a new exchange building in which to install a modern system in this city. This move on the part of the Bell people is thought to be due to the revolt of the patrons of the Citizens' Telephone Company which has announced an increase of rates to begin Jan. 1. A petition signed by 800 patrons declaring their intention to have the telephones taken out if the increase is adopted has not deterred the officials of the Citizens' Company, who insist on increasing the rates.

COLUMBUS, IND.—The officials of the Citizens' Telephone Company, of this city, announce an advance in the rates charged for telephones January 1. The present charge of $12, $18 and $24, for homes and business houses, will be increased to $15, $20 and $30 yearly. President Sherrin says the increase is made necessary because of the increased cost of operating a larger plant, together with the rapid growth of Columbus and the consequent call for more telephones. He says it is impossible to operate profitably on the present rates. The company will make no increase in the rate to farmers, the present contract with them will be respected.

INDIANAPOLIS, IND.—A club composed of a hundred employes of the Central Union Telephone Company in this city as charter members has been formed here. E. T. Bussele, chief inspector of the Indianapolis district, is president. The object of the club is for social pleasure and a school of instruction. The company furnishes free of rent a clubroom amply fitted up for social purposes and well equipped for a school of instruction. The club proposes giving an open reception once a month. Mr. Busselle will conduct a school of instruction in all the work of a telephone man, inside and outside, from the underground conduit system to the exchange switchboard, etc. The clubroom is open every day and night until 11 p. m., except on Sunday.

ELGIN, IA.—The Turkey River Farmers' Telephone Company has been organized.

RAKE, IA.—The Southwest Lincoln Telephone Company has been formed. H. H. Johnson is secretary.

SLOAN, IA.—Farmers near Albaton and Lossing are forming a telephone company and may start an exchange here.

LAKE MILLS, IA.—The Pike Run Telephone Company has extended its line into Leland and connected with the Leland Mutual Telephone Company.

MAYFIELD, KY.—The Mayfield Home Telephone Exchange has filed articles of incorporation for record in the County Clerk's office authorizing a capital of $50,000.

NEW ORLEANS, LA.—The Illinois Central Railroad will immediately begin the construction of a telephone system, which is to extend from New Orleans to Louisville, and from Fulton, Ky., to Chicago. The contract has already been let for this work to the Bell company and work will commence at once.

DETROIT, MICH.—The Michigan State Telephone Company will spend at least $2,000,000 in 1906 in improvements and extensions. The company will lay 5,000 miles of copper wire in the State, adding to its toll line service. It is building a new station at Delray, and another north of Gratiot, at Mutual Avenue. The capacity of the other offices is also being enlarged, and when the improvements are completed provision will be complete for the installation of 15,000 more telephones.

HANNIBAL, MO.—F. Darnell, of Carrollton, Mo., has been appointed general manager of the Bluff City Telephone Company, at Hannibal, vice H. G. Conger, resigned.

OMAHA, NEB.—The Nebraska Telephone Company has announced a reduction of 50 cents a month on business telephones and on individual and two-party line residence telephones. The company is now seeking to secure contracts at the reduced rate for the ensuing year.

ST. JOHN, N. B.—For some time negotiations have been pending between the directors of the Central Telephone Company and the Sackville Electric Light and Telephone Company and the two concerns have been amalgamated. The change will come into effect the first of January and doubtless will be the outcome of many improvements.

MILFORD, N. J.—The Delaware Valley Telephone Company has been formed; capital, $5,000. Incorporators: C. Rapp, W. H. Farrand and others.

JERSEY CITY, N. J.—The Reliance Telephone & Telegraph Company has been incorporated with a capital stock of $125,000 by Arthur Johns, Lanier McKee and Kenneth K. McLaren.

JERSEY CITY, N. J.—The Eastern States Telephone & Telegraph Company has been incorporated with a capital stock of $1,000,000 by Henry A. Bingham, Cornelius A. Cole and Alexander F. Garbe.

BATH, N. Y.—The Bath Hammondsport Telephone Company has been formed; capital, $5,000. Incorporators: Jas. H. Smellis, Wm. Dildine and others.

GLOVERSVILLE, N. Y.—A system which will accommodate between 5,000 and 6,000 subscribers will be installed in this city and Johnstown by the Independent Telephone Company. The company will form a part of the great independent system which is spreading throughout the State and country, and the local system will be operated in connection with the independent lines of Amsterdam, Troy and other cities of the State. Applications for franchises have been made to the Common Councils of Johnstown and Gloversville, and as soon as these are granted active operations will be commenced.

HAMMONDSPORT, N. Y.—The name of the newly organized company which has taken over the Niver lines, as referred to last week, is the Pleasant Valley Telephone Company. The capital stock is $5,000.

GLOVERSVILLE, N. Y.—The Independent Telephone Company of Fulton County has been incorporated with the Secretary of State to operate telephone lines between Gloversville and Johnstown, Fonda, Fultonville and Amsterdam and various other places in Fulton County. The capital stock is $5,000. The directors are Frederick M. Young, A. D. Kiblee and E. M. Brown, of Gloversville, and William T. Briggs and A. J. Baker, of Johnstown.

GREENSBORO, N. C.—The North State Telephone Company, of High Point, has been granted a franchise by the City Council. The franchise was stoutly opposed by the Southern Bell Company. The establishing of this long-distance service gives Greensboro direct connection with 1,200 stations of the North State Company's lines in the lumber and cotton mill sections of Randolph, Moore, Montgomery and Davie counties.

FARGO, N. D.—The new telephone service from Jamestown to Bismarck and Bismarck to Linton, has been inaugurated and will put Fargo in touch by two lines, with all points in South Dakota.

TOLEDO, OHIO.—The Western Ohio Telephone and Telegraph Company has been formed by John G. Meilink, A. C. Stevenson, F. E. Palmer, J. W. Davis, Joshua Lindahl. Capital stock, $100,000.

CLEVELAND, OHIO.—The Cleveland Telephone Company is preparing to erect a new building on Prospect Street, to cost between $40,000 and $50,000. It is stated that during next year $1,000,000 will be expended in extensions and betterments in Cleveland.

CLEVELAND, OHIO.—A statement prepared by Mr. T. P. Cagwin, of the Cleveland Telephone Company, shows that there was a total of 153,846 Bell subscribers stations in Ohio on Nov. 1, as compared with 130,011 on Jan. 1. This is a gain of 23,835, or 18 per cent in ten months. The Cleveland Telephone Company has about 25,000 telephones.

COLUMBUS, OHIO.—By the organization of the Union County Telephone Company, which has been promoted by Frank Beem of Columbus, Dwight Sapp of Mt. Vernon and capitalists of Marysville and Columbus, all the independent companies of Union County will be brought under one corporation. The independent exchanges at Marysville, Ridgewood and other country lines will be united under the new company.

CESTOS, OKLA.—The Independent Telephone Company has been formed, with a capital of $25,000. The incorporators are: J. W. Kerns, F. C. Hoyt and others.

CORSICA, S. D.—Articles of incorporation have been filed for the Sioux Falls Rock Telephone Company at Corsica, Douglas County, with a capital of $5,000. Incorporators, Joseph D. Hofer, Anna Hofer, A. A. Wipf and John J. Wipf.

MEMPHIS, TENN.—A new long-distance telephone system will be built and operated by the Cumberland Telephone Company from Memphis to Jackson, Miss.

NASHVILLE, TENN.—The city council without previous knowledge of the public has passed a resolution practically giving the Cumberland Telephone Company the right to construct its own conduits in the up-town district. A slight reduction in rates to the public and some minor privileges are given by the company as compensation for the rights granted.

NASHVILLE, TENN.—The capitalization of the Cumberland Telephone & Telegraph Company is to be increased 25 per cent Jan. 2, 1906, which will make the capitalization something between $16,500,000 and $17,000,000. The decision was reached to allow each stockholder to purchase at par an amount of new stock not exceeding 25 per cent of his holdings, the issue to be of record as of Jan. 2, 1906, but to be issued in four payments, one dated Feb. 1, and the others April 1, July 1, and Oct. 1, 1906.

MONTELL, TEX.—The Citizens Telephone Company of this city has increased its capital stock from $1,000 to $2,000.

TEXARKANA, TEX.—Although operating on both sides of the city for more than 20 years, it was recently discovered that the Southwestern Telegraph and Telephone Company has never had a franchise on the Texas side of the city. The City Council, on making this discovery, at once served notice on the company that it must apply for a franchise. Accordingly the Southwestern, at a meeting of the council, presented a bill for an ordinance for such franchise, but the council insisted on the insertion of two clauses, one to the effect that the company must pay to the city 3 per cent of its gross earnings, and the other providing that it must permit any and all local competing telephone companies to connect with its long-distance lines. The Southwestern promptly declined to accept a franchise containing such provisions, whereupon the Texarkana Telephone Company, a strictly local concern, presented to the council a proposition in writing to pay the city $100 per month for the exclusive right to operate a telephone business in Texarkana, Tex.

LYNCHBURG, VA.—The work on the new underground system of the Southern Bell Telephone Company in Lynchburg is rapidly reaching the stage where the new telephones can be connected, thus displacing the two old companies, which have been operating here for many years. The new service is costing the company upwards of $100,000 and will be modern in every detail.

CONNELL, WASH.—The Pacific States Telephone Company will install an exchange here.

COLUMBIA, WASH.—The Citizens' Telephone Company has been organized for the purpose of supplying telephone service for the town of Columbia and suburban districts as far as Renton.

SEATTLE, WASH.—Articles of incorporation have been filed for the Citizens' Telephone Company; capital stock, $100,000. Directors, Van R. Peirson, Edward E. Webster, Algert G. Corbett, Eugene A. Marsh, Ralph D. Nichols.

TACOMA, WASH.—The city council has granted a franchise to the Independent Telephone Company, which will install an automatic system at a cost of $500,000. The company is required to expend $50,000 within six months and $100,000 within one year.

BELLINGHAM, WASH.—The directors of the Farmer's Mutual Telephone Company have elected the following officers: President, Ed. Brown, of Custer; vice-president, J. W. Sefton, of Everson; secretary, S. F. Bailey, Lynden; treasurer, J. C. Gillies, Nooksack. The Automatic Company has secured its franchise in Bellingham, and arrangements have been definitely made whereby the Farmer's Company will meet this company at the city limits of Bellingham as soon as the lines can be completed.

WAUKESHA, WIS.—The stockholders of the Eagle Telephone Company have voted to increase the capital stock from $15,000 to $20,000. The company intends improving and enlarging its several exchanges.

VANCOUVER, B. C.—The British Columbia Telephone Company will string two direct copper wires between this city and Seattle, a distance of 150 miles.

BRANTFORD, CAN.—The special telephone committee of the Brantford City Council has decided to recommend to the Council that the Canadian Machine Telephone Company be given a competitive franchise in that city. It had two companies to choose between, the Canadian Machine and the Ontario Telephone Company. The one selected is a Brantford invention, the Lorimer automatic telephone system.

Electric Light and Power.

ALBERTVILLE, ALA.—Arrangements are being made to commence work on the power plant, which is to be built by the North Alabama Railway, Light & Power Company, on Town Creek, near this city.

MOBILE, ALA.—It is understood a New York company has secured control of the lighting company of Mobile. It is reported that J. Howard Wilson, president of the Mobile Light & Railroad Company, is one of the interested parties.

ANNISTON, ALA.—The Coosa River Electric Power Company has been incorporated, with principal office at Birmingham, and a capital of $100,000, to develop and utilize the water power of Coosa River, at Ten Island Shoals, by building a dam, power house, and transmission lines to Anniston, Gadsden, Attalla, Alabama City, Pell City, Riverside and other cities. R. H. Cobb, of Anniston, is vice-president.

DARDANELLE, ARK.—The new municipal electric light plant has been completed here and the people report the service as very satisfactory.

ARGENTA, ARK.—Bids will be received until Jan. 15 by C. J. Humphreys, Secretary Board of Improvements for furnishing all the material required in the construction of the water works and electric light plant here.

LAKE CITY, FLA.—Bids will probably soon be called for a $15,000 addition to the electric light plant. J. C. Sheffield is chairman of the Board of Public Works.

VISALIA, CAL.—A. G. Wishon, of Fresno, is said to have been granted a franchise for the construction of a power line across Tulare County.

SAN BERNARDINO, CAL.—The Mill Street power plant of the San Bernardino Electric Company has been destroyed by fire.

CHICO, CAL.—The city trustees have granted to the Northern Pacific Power Company permission to enter the city by way of Main Street.

NEEDLES, CAL.—Danl. Murphy, of Los Angeles, is interested in the construction of a power plant at Needles, to furnish light and power to the town and mines.

FRESNO, CAL.—A. G. Wishon, general manager of the Joaquin Light & Power Company, writes that it is proposed to construct a transmission line with hydraulic plants, at a cost of about $1,000,000. It will not be built by contract. D. L. Wishon, of Visalia, is engineer.

HALFMOON BAY, CAL.—W. E. Alexander has petitioned the supervisors of San Mateo County at Redwood City for a franchise permitting him to lay mains in the streets of Halfmoon Bay and to erect and maintain poles and wires for supplying gas and electricity for light, heat and power purposes.

GILROY, CAL.—On November 28, the City Council ordered that the bid of the Tracy Engineering Company, of San Francisco, of $7,943.90, for the constructing and equipping of the municipal lighting plant, be accepted. The plans call for the completion of the work within 75 days from the signing of the contract.

SAN FRANCISCO, CAL.—The California & Nevada Mining & Milling Company contemplate the installation of an electric power plant at Big Pine, Cal., which will transmit power to mines in the Goldfield and Bullfrog districts. George S. Wheatly, of this city, says that his company controls 1,000 inches of water and will spend $1,500,000 on the new system.

SAN FRANCISCO, CAL.—The Stanislaus Power Company, which has been organized with a capitalization of $10,000,000, with $6,000,000 subscribed, is making headway on its plans to transmit electric power to San Francisco. It is understood that some of the capitalists who financed the San Francisco Coke & Gas Company are behind the new power project. Hydraulic work is progressing.

SAN FRANCISCO, CAL.—The Metropolitan Laundry Company has received bids for an electric power plant and motors for operating all the machines by individual drive. About 80 direct-current motors will be required. Two 150-kw direct-current generators will be direct connected to two 250-hp engines. The estimated cost of the steam plant and electric equipment is about $60,000.

NAPA, CAL.—Attorney Raymond Benjamin, of this city, has petitioned the Board of Supervisors of Napa County, for a 50-year franchise for a light and power plant. A company is being organized by J. S. McDonald, of San Francisco, to generate power at Napa and supply electricity to Oakville, Yountville, Rutherford, St. Helena, Calistoga and Napa. Bids for said franchise will be received until January 12 at the office of W. N. Collins, Clerk, Board of Supervisors.

SAN FRANCISCO, CAL.—The Mount Whitney Power Company, which is reconstructing its transmission system, recently closed a contract through Hunt, Mirk & Co., for a complete electric generating plant to cost about $100,000, erected at Visalia, Cal. A 1,000-kw. Wesinghouse-Parsons turbo-generator will supply 3-phase current, the line voltage being 15,000 volts, with an increase to 30,000 volts proposed. The plant will be operated about five months of each year, during the dry season, being intended for a steam reserve plant. It will tie in with the company's two hydro-electric transmission plants, about 35 miles of additional pole line being required.

SALIDA, COL.—The water power plant of the Salida Light, Power & Utility Company is to be greatly enlarged and improved. It is the intention of the company to expend about $85,000 for this purpose.

GEORGETOWN, COL.—Upper Clear Creek is soon to have another electric power plant of large capacity. W. E. Renshaw, of Idaho Springs, has entered the field and expects soon to be in position to furnish power to the mines.

GEORGETOWN, COL.—E. J. Wilcox, of Denver, chief promoter of the Waldorf Mining Company, writes that bids for construction work in connection with the proposed power development will be received about April 15.

SQUIRREL GULCH, COL.—The Mount Theresa Gold Mining Company, of which W. E. Garver, Idaho Springs, Col., is manager, will erect a water power plant on Soda Creek, near Squirrel Gulch, Col., to generate electric power, etc., to run hoist and drills.

GREELEY, COL.—J. J. Hendrie, of Denver, has filed a petition with the County Commissioners for a 50-year franchise over the county roads for poles, wires, etc. It is stated that a power plant will probably be constructed at Lafayette or Louisville and transmission lines constructed from there to Greeley, Windsor, Ft. Collins, Cheyenne and Denver.

TORRINGTON, CONN.—It is understood that the Torrington Electric Light Company is shortly to build an addition to its plant on East Branch Street.

WILMINGTON, DEL.—Officers of the new Wilmington Heat, Light & Power Company, which was recently granted a franchise for the establishment of an electric lighting plant in this city, intends to begin constructing the new power plant early in the spring. Considerable detail work is now being done and the plans for the new plant are well under way.

ORLANDO, FLA.—The Orlando Water & Light Company has purchased the entire plant and business of the South Florida Gas Company and will assume the management of the same on January 1.

BRUNSWICK, GA.—Much of the machinery at the plant of the Mutual Light & Water Company was damaged by a recent fire.

ROME, GA.—The City Council has granted franchises to the Etowah Power Company, which will construct a plant at Cartersville, and to the Little River Power Company, whose power plant will be on Lookout Mountain, 30 miles from Gadsden.

DUBLIN, GA.—The work of changing the system at the electric light and power plant from a high to a low frequency system has been accomplished.

SAVANNAH, GA.—The Savannah Electric Company will erect an addition to its Indian Street station, where power for the street railway system will be generated. It is the purpose of the company to combine the two plants' generating power for both lighting and railway purposes. The machinery and the building of the extension will represent an investment of over $100,000.

NAMPA, IDA.—Frederick Irwin, manager of the Trade Dollar Consolidated Company, was in town recently securing contracts for electric power to be furnished this town and Caldwell from the company's power plant at Swan Falls.

MONMOUTH, ILL.—The Monmouth Gas & Electric Company is contemplating rebuilding its entire plant in the early spring.

CHICAGO, ILL.—The Illinois Athletic Electric Club Company, with a capital of $2,500, was recently inncorporated for the purpose of furnishing electricity for light, heat and power.

AURORA, ILL.—The City Council is considering a proposal for the installation of a new electric light plant. It is estimated that the new system would cost about $20,000.

ROCKFORD, ILL.—A petition is to be placed before the Council for an increase in the appropriation, making it $25,000, in order to provide for 15 new lights which are to be installed this next year, three in each ward.

ELGIN, ILL.—Anson B. Root, president Elgin Hydraulic Company, will organize the Elgin Hydraulic Heat, Power & Light Company, for the purpose of supplying electricity in this city.

LEWISTOWN, ILL.—The Fisher Power, Heat & Electric Lighting Company, of Lewistown, has been incorporated with a capital of $20,000. The incorporators are: Floyd M. Condit, Theo. Fisher and H. W. Masters.

MONTGOMERY, IND.—Arrangements are under way for the erection of a new electric lighting plant here.

OWENSVILLE, IND.—The Owensville Electric Light Company has petitioned the town council for a franchise for an electric light plant.

COLUMBUS, IND.—The business men of this city are circulating a petition asking that the City Council adopt a resolution whereby a commercial lighting plant can be established.

AURORA, IND.—The Indiana Public Service Company has been incorporated for the purpose of constructing a light and heating plant. David J. Hauss is president of the new concern.

MARION, IND.—The question of establishing a municipal lighting plant is being widely discussed here. It is asserted that the city would save enough in seven years to entirely pay for the necessary plant.

PERU, IND.—Capitalists of this city are said to have obtained a franchise for an electric light plant at Arcadia. The same plant will also furnish electricity for lighting the streets of Atlanta, three miles distant.

COLUMBUS, IND.—The City Council is reported to have taken steps toward the construction and equipment of a commercial lighting plant in this city. The present service is furnished by the Columbus Street Railway Company.

LAPORTE, IND.—The city council of Laporte has entered into a ten-year contract with the Laporte Electric Company for an all-night lighting service, at $73 per light per year. The company will add new equipment and make some extensions.

RICHMOND, IND.—At a recent meeting of the City Council action was taken toward increasing the capacity of the municipal lighting and power plant. The board was instructed to employ an electrical engineer to draw up plans and specifications for the addition of another unit to the equipment.

SHELBYVILLE, IND.—The City Council of Shelbyville, Ind., is considering the putting in of a city lighting system. Mr. Chas. L. Henry, president of the Indianapolis & Cincinnati Traction Company, has offered to sell the Shelbyville power house, boilers, engines and part of the electric equipment, for $25,000.

RICHMOND, IND.—The municipal lighting question is up again in this city. The commissioners are asking for $40,000 to purchase necessary apparatus to replace old and wornout equipment. The taxpayers are almost ready to revolt. The original plant cost the city $144,000 and there has been spent since the acceptance for building and new equipment $71,891. The total income of the plant has been $121,348.28. Total excess of cost of plant, since its acceptance, over its income, $48,689.45, and now that $40,000 more is demanded municipal lighting in Richmond is much in disfavor.

ACKLEY, IA.—Mr. John Rath recently made the city a gift of a complete electric light plant.

HARTLEY, IA.—It is reported that Ira Steele is interested in the installation of an electric light plant.

MILLERSBURG, IA.—The Fairbanks & Morse Electric Company, of Chicago, Ill., is preparing to install an electric light plant in this town.

WATERLOO, IA.—The Waterloo and Cedar Falls Gas and Electric Light Company has passed over to the management of new officers and directors.

PRYOR CREEK, I. T.—This place will have an electric plant within ninety days. The Council has granted to D. E. Little, of Waggener, I. T., a 25-year franchise for the erection and maintenance of a plant.

HOLDENVILLE, I. T.—R. O. Wall and W. M. Dunn have been to Ada, I. T., on business connected with the new electric light plant. Work will begin on the buildings just as soon as the material can be gotten on the ground and it is now being placed there.

TULSA, IND. TER.—Control of the People's Gas Company and the People's Power Company, by the sale, December 15, of the stock of the Cherokee National Oil Company, in the two corporations, passed to Dan Murphy, of Los Angeles, Cal.; P. De C. Bell, of St. Louis, and P. H. Anderson, of Tulsa. Ed. C. Reynolds and other local parties are still interested. The purchase includes franchises for gas mains and city lighting service, together with seven gas wells and several miles of pipe line.

STAFFORD, KAN.—The electric light plant here has been overhauled and made practically new. The plant now has a capacity for 2,800 lights.

HERINGTON, KAN.—The Herington Light, Power & Water Company has filed articles of incorporation and applied for a franchise to establish a power plant.

LINCOLN CENTER, KAN.—The new electric light plant and water works which it is proposed to construct here, it is estimated, will cost $34,500. The office of the works committee is at Lincoln, Kan.

HARPER, KAN.—The electric light plant here is being installed and will be ready for operation by the middle of January. The company has secured contracts for wiring many homes and business houses.

OSAWATOMIE, KAN.—The Osawatomie Electric Light & Power Co. will receive bids about April 1 for the construction of an electric light plant, at a cost of $10,000. The company will add an ice plant later on.

BELLEVILLE, KAN.—At a meeting held by the citizens of Belleville it was the expression of those present that the city erect a $20,000 electric plant and run it in conjunction with the water works. There is a company organized in the city whose purpose is to erect an electric light plant and it may be possible that this company and the City Council will act together.

PITTSBURG, KAN.—At its last regular meeting the City Council passed the ordinance granting a franchise to W. Milburne, of Jackson, Tenn., for the placing of an electric light plant in this city. According to the terms of the ordinance passed, W. Milburne, the contractor, has been given 30 days within which to file his acceptance of the contract, 60 days within which to commence work on the plant, and the ordinance also provides that the plant shall be completed within a period of seven months.

LOUISVILLE, KY.—Articles of incorporation have been filed by the Louisville & Northern Railway & Lighting Company, which expects to operate between this city and Indianapolis or Chicago.

FORT FAIRFIELD, ME.—A meeting has been held to discuss the project of utilizing the power at the Aroostook Falls to be developed by the Maine & New Brunswick Electrical Power Company.

TANEYTOWN, MD.—A charter has been granted to Edward E. Reindollar, D. J. Hesson, Joseph E. Roelkey and others, to construct an electric light plant here, at a cost of from $8,000 to $10,000. A 100-hp engine, 125-hp boiler and a 1,000-light dynamo will be installed.

BRUNSWICK, MD.—The electric power from the Shenandoah river plant of the Harper's Ferry Light and Power Company has been turned on in Brunswick. After a short period the power company will be in position to quote rates on cheap electric power, which will naturally attract manufacturing plants to Brunswick, as there is an abundance of good labor available.

BALTIMORE, MD.—The Consolidated Gas, Electric Light & Power Company has filed its answer in Baltimore to the bill of complaint of the Maryland Telephone Company, for an injunction restraining the Consolidated from interfering with the wires of the Maryland Company. The answer alleges that the Maryland Company is restricted to the use of certain poles in the city for telephone purposes only and not for lighting or heating.

BALTIMORE, MD.—A contract made by the city of Baltimore with the Consolidated Gas, Electric Light and Power Company, which will run for five years from September, 1905, fixes the flat rate of $67.49 per arc lamp per year. The rate for incandescent lamps used by the municipality is 6 3-10 cents per kw-hour. For five years prior to the letting of the present contract current for the arc lamps was furnished by the United Electric Light and Power Company, the predecessors of the present corporation. The price was $99.92 per lamp per year and the contract made in 1900 expired last September. For a number of years prior to that time the city had been paying $127.75 per lamp per year, or at the rate of 35 cents per lamp per night. Steam is the power used and coal has an average cost of $3.20 cents a ton.

NEW ALBANY, MASS.—The citizens have voted to issue $9,000 bonds for extending the electric light plant.

AMESBURY, MASS.—The Howarth & Rogers Co. will equip a new carriage and automobile body plant with about 55 hp of electric motors.

QUINCY, MASS.—The City Council has asked the Mayor to secure special legislation enabling Quincy to put in a plant for municipal purposes only.

GARDNER, MASS.—The Gardner Electric Light Company announces a reduction of from 20 to 15 cents per kw-hour used for residential purposes commencing January 1.

LEOMINSTER, MASS.—The extensive improvements to the Leominster electric light system, which have been under way for the past few weeks are now nearly completed.

LENOX, MASS.—The Lenox Electric Light Company is soon to make a number of improvements on its lighting system. The entire equipment will be generally overhauled, and the new transformers will replace several of the old patterns.

ADRIAN, MICH.—The Schwartz Electric Company has voted to increase the capital stock from $25,000 to $100,000. The company will erect a larger building in the spring.

FAIRVIEW, MICH.—The council has given the contract for lighting the village to the Peninsular Electric Lighting Company, of Detroit, at $67.60 per light per year. About 30 lights will be used.

LANSING, MICH.—The electric light and water board has awarded the contract for 150 enclosed, alternating current arc lights to the Adams Bagnall Electric Company of Cleveland, Ohio, for $3,801. It is expected that the new system of lighting will be in use in about three months.

TWIN VALLEY, MINN.—Work is being pushed as rapidly as possible on the new electric light plant which is being installed by Frank Magnuson.

DULUTH, MINN.—The Board of Water and Light Commissioners has asked the Council for authority to submit to the voters a proposition to issue $75,000 water and light bonds.

ST. PAUL, MINN.—The St. Paul Gas Light Company has secured the contract for maintaining 519 overhead electric lamps at $90 per light per year, and for each additional lamp $8 per month.

DULUTH, MINN.—The Great Northern Power Company, of this city, has under construction a large generating plant on the St. Louis River, which will be capable when completed of developing 80,000 horse-power.

MINNEAPOLIS, MINN.—City Engineer Andrew Rinker has been requested to investigate the matter of utilizing the water power at the falls of St. Anthony, the power to be used for lighting the city hall and other public buildings.

ST. JOSEPH, MINN.—The Sisters of the Order of St. Benedict are reported to have secured a franchise for an electric light plant. It is proposed to install the plant at St. Benedict's Academy and furnish the village, also private consumers, with electric lights.

MANKATO, MINN.—At a meeting of the directors of the Mankato Gas and Electric Light Company, H. A. Patterson resigned as president and John B. Meagher was elected to fill the vacancy. The company contemplates some radical and needed improvements in its plant here.

ST. PAUL, MINN.—A. B. Stickney, Oliver Crosby and G. F. Philleo have filed articles of incorporation for the West Side Power, Heat & Light Company, with a capital of $50,000. It is proposed to construct a plant of 2,000 or 3,000 hp to supply some of the manufacturing plants on the west side with electric light and power.

RED WING, MINN.—The Red Wing Gas Light & Electric Company, which succeeds the Red Wing Gas & Electric Company, has been organized with a capital of $250,000. The board of directors consist of O. M. Hall and P. C. Thompson, of Red Wing, A. E. F. White, Frank N. Crosby and Ralph L. Aldrich, of Detroit, Mich., and Frederick Platt, of Flint, Mich. The officers are: President A. E. R. White; vice-president, O. M. Hall; secretary and treasurer, P. C. Thompson.

MINNEAPOLIS, MINN.—In connection with their plans for increasing their electrical business in Minneapolis by the improvement of the water power at Taylor's Falls, Wis., Stone & Webster, of Boston, general managers of the Minneapolis General Electric Company, announce a new management in the Minneapolis office. A. W. Leonard, manager of the Electric Light & Street Railway Companies, of Houghton, Mich., will succeed A. M. Robertson as manager of the Minneapolis General Electric Company.

BRAYMER, MO.—The question of installing a municipal electric light plant is being agitated here very strongly.

BOWLING GREEN, MO.—The Pike County Electric Light and Power Company, of Bowling Green, has increased its capital stock from $7,000 to $10,000.

JOPLIN, MO.—C. H. Barron and David D. Hoag have filed articles of incorporation for the Consolidated Light & Power Company, with a capital of $1,000,000.

ST. LOUIS, MO.—Charles Ware, George Kingsland and Thomas C. Henning have petitioned the House of Delegates for permission to construct a heating and lighting plant in Maplewood near the city limits.

ST. LOUIS, MO.—A bill was introduced into the Municipal Assembly, December 15, to allow a company composed of Charles Ware, George Kingsland and Thomas C. Henning to construct and operate a heating and lighting plant in Maplewood, near the city limits. The concern agrees to give to the city 1 per cent. of its net earnings for the first year.

WOOD RIVER, NEB.—Plans and specifications are being prepared for a lighting plant and water works.

CREIGHTON, NEB.—The citizens have organized a stock company, with a capital of $25,000, for the purpose of installing an electric light plant.

NEW BRUNSWICK, N. J.—The Middlesex Light & Equipment Company has been incorporated with a capital stock of $50,000. The incorporators are Louis Wolfron, William Schlessinger and William Wolfron.

PASSAIC, N. J.—At the last meeting of the Passaic city council the members of the street lights committee submitted a report recommending that the city enter into a 5-year contract with the Public Service Corporation for lighting the streets of the city and furnishing its residents with electricity for commercial purposes. The terms of this contract are as follows: Arc light, $85 per year; incandescent lights, 12 cents per kw-hour for the first two years, 11 cents per kw-hour for the second two years and 10 cents for the fifth year.

UNION, N. Y.—H. B. Sweet, of Utica, is engineer for the proposed electric light plant, which will cost about $15,000.

HENRIETTA, N. Y.—The Niagara, Lockport & Ontario Power Company is said to have purchased property in Henrietta upon which to erect a sub-station.

ALBANY, N. Y.—The Hudson River Electric Power Company, of Albany, N. Y., reports an increased demand for power from the Watervliet Arsenal. It is at present using about 300 horse-power. This has been in service during the past year and the officers of the Arsenal are so well pleased with the satisfactory service rendered that they have notified the Power Company that 200 horse-power in addition will be required, and the order has been placed for the necessary electrical apparatus.

ASHEVILLE, N. C.—The Asheville Cotton Mills have contracted for 700 horse-power from the Weaver Power Company from its plant on the French Broad River.

MORGANTOWN, N. C.—The new power house for the town has been completed, the work having been done under the supervision of the General Electric Company.

WINSTON, N. C.—The Fries Manufacturing & Power Company has secured permission to build certain additions to its system in this town.

UTICA, N. Y.—The Utica Gas & Electric Company has nearly completed the construction of the pole line between that city and Rome, over which power will be transmitted to light the streets of Rome. About 600 poles have been placed. The power for lighting Rome will come from the Trenton Falls plant of the Utica Gas & Electric Company. About 1,000 hp will be required at first, and all will be in readiness to turn the current on by January 1, it is expected.

CHARLOTTE, N. C.—The Southern Power Company has added to its already extensive properties the "99" Islands, a fine water power on Broad River, where about 12,000 hp will be developed. The company expects to spend about $1,000,000 at this point. The Southern Power Company recently awarded to the Holyoke Machine Company a contract for a water-wheel equipment to be installed in the first of the nine large hydro-electric plants which the company contemplates erecting in North Carolina. This plant will have a capacity of 30,000 hp in units of 5,000 hp each. It is to be built at Great Falls on the Catawba River, near Charlotte. The wheels will operate on a fall of 175 feet. Delivery will be made next year. The company has secured all the falls on the Catawba. An officer of the company said recently that inside of four years they expected to develop nearly 150,000 hp, with which they anticipate operating all the biggest cotton mills in the Carolinas. The electric current will be delivered over a 40,000-volt transmission line, about 180 miles long. It will cost the mills about $20 per hp-year. At present anything from $23 to $45 per hp-year is paid for energy generated by steam. Work is to commence on another 30,000 hp plant inside of the next few weeks. Before the completion of all the plants fully $5,000,000 will have been expended.

HOPE, N. D.—The advisability of constructing water works and an electric light plant is being discussed here.

LANGDON, N. D.—Liebler & Finnerty have purchased the local electric light plant and will make improvements thereto, including the addition of a boiler.

GRAND FORKS, N. D.—The Grand Forks Gas & Electric Company is making arrangements for the erection of a new power house. W. J. Murphy is general manager of the company.

COOPERSTOWN, N. D.—The equipment for the electric lighting plant has arrived and is being installed as rapidly as possible. It will probably not be long before the plant is in operation.

ALBUQUERQUE, N. M.—The Rio Grande Land, Water & Power Company has been incorporated with a capital of $1,000,000 by A. W. Hoffman, W. B. Childer and others of this city.

SILVER CITY, N. M.—The Silverton Electric Light Company, of this city, has secured the contract for furnishing current for the electric light system which is soon to be established in Aztec.

XENIA, OHIO.—The City Council has granted to the Citizens' Light & Power Company a franchise to furnish light and power to the city.

LIMA, OHIO.—J. W. Halfhill, of this city, and H. L. Canfield, of Delphos, have petitioned for a franchise to construct and maintain an electric light plant here.

COLUMBUS, OHIO.—Resolutions have been adopted favoring the appointment of a committee to make a house-to-house examination of meters, pipes, etc., in an effort to discover the cause of the poor quality of light furnished, about which many complaints have been made. The Columbus Railroad Company was also requested to furnish hereafter new globes for electric lights wherever needed without cost when in exchange for old ones previously purchased from it.

CLEVELAND, OHIO.—By the annexation of South Brooklyn the city has obtained possession of a large electric light plant. Mayor Tom L. Johnson has revealed his plans to extend the usefulness of the plant over a larger area and use it to compel a reduction in rates. The city is now having figures compiled with a view of lighting practically one-third of the city from the South Brooklyn plant. The aim of Mayor Johnson to obtain a municipal lighting plant has been realized in the acquisition of the suburban institution.

SALEM, ORE.—The Union Light & Power Company, of Silverton, has been sold to the Citizens' Light & Traction Company.

HEPPNER, ORE.—The citizens are discussing the question of establishing an electric light and water works.

SILVERTON, ORE.—The Citizens' Light & Traction Company, of Salem, has purchased the plant of the Union Light & Power Company, of this city. They will rebuild the dam and develop all the power possible. Mr. A. Welch is manager of the purchasing company.

PORTLAND, ORE.—The proposed power plant of the Cascade Power Company will be located about 50 miles from Portland, the water to be taken from Zig Zag, Still and Camp Creeks, to furnish about 30,000 horsepower. The cost of the proposed work will be about $650,000.

WATONGA, OKLA.—It is proposed to construct an electric light plant at a cost of $6,000. G. E. Moore is town clerk.

STEELTON, PA.—The Steelton Light, Heat & Power Company, whose plant was destroyed by fire, will rebuild on a new site.

YORK, PA.—The large hydro-electric power plant which is to be erected at McCall's Ferry by the McCall's Ferry Power Company is now fairly under way.

BIRDSBORO, PA.—An electric light plant is to be erected on the Schuylkill River at this point, but none of the details of the project have been given out as yet.

PHILADELPHIA, PA.—The Philadelphia Electric Company has secured the contract for lighting the streets by electricity for the year 1906, for a total of $1,073,272.

SALISBURY, PA.—The Citizens' Light, Heat & Power Company has been incorporated with a capital of $10,000, by John Meager, H. H. Maust, Richard B. Newman, and others.

PITTSBURG, PA.—The Chemical Light, Heat & Power Company, of Pittsburg, has been formed to construct a plant at Beaver Falls, to cost about $200,000. This company is reported to have taken over the plant of the Wooster Gas Light Company, of Wooster, Ohio; the plant of the McWatters By-Products and Gas Manufacturing Company, at Beaver Falls, and will take over four other gas and electric light plants in Ohio and Pennsylvania. Thomas McWatters is the manager.

PROVIDENCE, R. I.—The Narragansett Electric Light Company has the contract for lighting the city for six years, the first three years to be at $104.75 per light per year and the next three years at $100 per light per year.

ST. MATTHEWS, S. C.—An election will probably soon be held to vote on issuing $20,000 bonds for an electric light plant and water works.

FLORENCE, S. C.—Bids will probably be received about Feb. 1 for the development of the power of Black Creek, near Florence, for the Florence Light & Power Co. The probable cost of the work will be $150,000.

ABERDEEN, S. D.—It is stated that $35,000 municipal light bonds have been sold here.

CANTON, S. D.—The Canton Milling Company proposes to install a $20,000 electric light plant and water works system for the town.

TREZEVANT, TENN.—The question of constructing water works and an electric light plant is said to be under consideration here.

GREENFIELD, TENN.—Coates Bros. & Barton have purchased the plant of the Greenfield Electric Light & Water Company, which was formerly owned and managed by Harry C. Ward.

KNOXVILLE, TENN.—A statement in a local paper at Knoxville says that the city will pay $72.50 per light next year while Savannah, Ga., will pay $39,000 for the year's contract, the number of lights not being given. In Richmond, Va., $54.75 is being paid per light for 650 lights, or a total of $35,587 per year.

SOUTH PITTSBURG, TENN.—Some weeks ago the South Pittsburg Electric Light & Power Company offered to sell the entire plant to the city for $3,000, payable in two years, with notes bearing 6 per cent. The Board of Mayor and Aldermen ordered an election and the proposition was accepted by 124 votes for it and 44 against.

FAYETTEVILLE, TENN.—B. E. and J. W. Holman, J. H. Thompson and T. W. Caudle, of Fayetteville, have purchased the electric light plant at Dayton, Tenn., and charter has been applied for. The capital stock of the company, which will be known as the Dayton Electric Light Company, will be $10,000. Improvements amounting to $2,500 will be made on the plant at once. J. W. Holman is president; B. E. Holman, secretary and treasurer; W. J. Holman, superintendent; T. W. Caudle, general manager.

KILLEEN, TEX.—McDowell & Burks, of this place, have been granted a 50-year franchise for the operation of an electric light plant.

BRYAN, TEX.—The Bryan Water, Ice & Power Company has filed an amendment to its charter, increasing its capital stock from $20,000 to $40,000.

SALT LAKE CITY, UTAH.—Frank Taylor, of this city, has filed application with the State Engineer for 200 sec.-feet of water from Weber River, in Summit County, to be utilized for generating current for electric lighting and power purposes at Oakley, this State.

BEAVER, UTAH.—Lucien L. Nunn, of Provo, has filed an application for 40 second-feet of water to be diverted from Beaver River. If granted he will establish a plant at Beaver to furnish heat, light and motive power for this city, Milford, Frisco and Newhouse; also to mines in Gold Mountain, Mt. Nebo, Ohio and Maryvale mining districts.

OGDEN, UTAH.—L. B. Spencer, consulting engineer for the South Fork Power & Irrigation Company, writes that it is proposed to construct a reservoir, dam and power house at an aggregate cost of about $500,000. The preliminary work has not yet been completed, as the work has been stopped on account of the weather; it will be resumed, however, in the early spring.

SALT LAKE CITY, UTAH.—Chas. W. Johnson of this city has filed application at the State Engineers' office, for ten feet-second of water from Puffer Lake for power purposes. The diverting channel is to consist of a tunnel 3 ft. wide and 5 ft. high. From the tunnel a pipe line will be constructed a distance of 15,000 ft. to where the power plant will be constructed. The power will be used for lighting and driving machinery in Marysvale and Kimberly.

MONTPELIER, VT.—The new power plant of the Lake Dunmore Power & Traction Company, of which E. D. Blackwell is manager, is almost completed. The plant is thoroughly equipped with up to date machinery, a new house, a boiler of 150 hp capacity, two water wheels of 110 hp each, while the electric generating plant is of the best.

PORT TOWNSEND, WASH.—A franchise has been granted to John Siebenbaum for the operation of an electric light plant.

SEATTLE, WASH.—The name of the Priest Rapids Irrigation & Power Company has been changed to Hanford Irrigation & Power Company.

WALLA WALLA, WASH.—The Northwestern Gas & Electric Company has secured the contract for installing the necessary electric motors to operate the machinery at the Penitentiary jute mill and will furnish the power for running the machines.

PROSSER, WASH.—The County Commissioners have granted the Prosser Falls Land & Power Company a franchise to construct a transmission line along the county road to the western boundary for the purpose of transmitting electric power to Sunnyside.

EVERETT, WASH.—The City Council has granted to Clay Allen, of Seattle, representing the Snoqualmie Light & Power Company, a three-year franchise; also a contract for lighting the city for that period at $6.50 per light per month. The system will be installed at once and it is hoped to have it completed by March 1, 1906.

ARLINGTON, WASH.—Mr. E. C. Robinson has accepted the position of superintendent and manager of the Jim Creek Power, Light & Water Company, of Arlington. He will install a 200-kw water turbine-generator set about 4½ miles from the town. Mr. Thomas Moran has purchased the Arlington Water & Light Company's steam plant. Mr. Moran is the principal owner of the Jim Creek Company.

PORT TOWNSEND, WASH.—A petition for a franchise has been filed by H. M. Bennett and A. E. Sims, who propose to establish an electric light plant.

SEATTLE, WASH.—The Seattle-Tacoma Power Company is preparing to build a transmission line from Snoqualmie Falls down the river to Everett. O. D. Colvin, of Seattle, is manager of the company.

SOUTH BEND, WASH.—J. M. Etnier has assigned his electric light franchise to M. E. Walsh, who, it is stated, will form a company for the construction of an electric light plant to furnish South Bend and Raymond with electricity.

KAUKAUNA, WIS.—The Kaukauna Electric Light Company proposes to double the capacity of its plant, and for this purpose will install another generator in addition to its present equipment.

LADYSMITH, WIS.—The property of the Ladysmith Light and Power Company, including the real estate, equipment, poles, wires and franchise has been sold to G. E. Newman at public sale for $3,100. Improvements are planned.

MILWAUKEE, WIS.—The city council has turned down municipal ownership projects by voting to continue street lighting by the Milwaukee Electric Railway & Light Company at present prices after the expiration of the old contract. This means $81 a year per arc on overhead circuits and $99 for those on underground circuits.

WASHBURN, WIS.—After being in darkness for more than two months the streets of this city are again being lighted, the City Council and the Washburn Electric & Power Company having agreed upon a price to be paid for lighting. No new contracts were entered into, but the lights have been turned on, to be cut off at the option of the council. The contract between the city and the company, which has been in force for 15 years and for which the city has been paying $11.24 for each lamp per month, has expired and the new rate for lighting on the midnight schedule has been agreed upon at $5.50 per lamp per month, but it is the opinion of the council that this rate is too high and an effort will no doubt be made in the near future to have it lowered.

ARMSTRONG, B. C.—The Armstrong Light, Power & Traction Company is being formed here to build lines between Kamloops, Enderby, Armstrong, Vernon and from thence down the valley. New York capitalists are said to be interested in the enterprise.

CRANBROOK, B. C.—The East Kootenay Power & Light Company has been registered here with a capital of $150,000. The incorporators are: Robert Campbell, Moyie, B. C.; John D. Kay, Moyie, B. C.; James A. McDonald, Cranbrook; F. C. Parkes and Charles A. Mackay, Nelson, B. C. It is the intention of the company to supply the East Kootenay country with light and power. Operations will be commenced as soon as certain franchises have been granted.

MOOSEJAW, CAN.—The ratepayers have passed a bylaw to spend $30,000 on building an electric light plant. Thomas Miller is interested.

VILLA DE ALVAREZ, MEX.—The El Mamey Iron Company will install a large hydro-electric plant at the falls of the Mamey River near Villa de Alvarez.

TORREON, MEX.—A new electric light company is being formed in Torreon by local citizens. More than $100,000 of the capital stock has already been subscribed.

IRAPUATO, MEX.—The Compania Exploradora de las Fuerzas Hidro-Electricas del Rio Angulo, which was recently organized with a capital stock of $2,000,000, will install a hydro-electric plant near Irapuato.

TOLUCA, MEX.—A syndicate of Philadelphia, Pa., men are arranging to install an electric power plant on the brow of an extinct volcano near here for the purpose of supplying a number of towns adjacent to Toluca with light and power.

GUADALAJARA, MEX.—The Facundo Perez water concession, covering the use of the water of the Santiago River between Las Juntas and San Cristobal, a distance of about 30 miles, has been purchased by La Electra, S. A., the light and power company of Guadalajara. The price paid for the concession was $125,000.

TORONTO, ONT.—The Toronto Electric Light Company has secured the contract for lighting the city for five years at 19 cents per light per night.

HAMILTON, ONT.—The Canadian District Heating Company is arranging to construct a $100,000 electric light plant and power plant. Bids will probably be called for in March.

TORONTO, ONT.—The Imperial Electric Motor Company has been incorporated here with a capital of $200,000 to manufacture power machinery, automobiles, etc. The directors are Andrew Dods, Robert McKay, Gideon Grant, Toronto.

PARIS, ONT.—The Stark Electric Light, Power & Telephone Company has come forward with an offer to purchase the municipal lighting plant of Paris. The Town Council has set a price of $50,000 upon the plant. The company states that it will sell energy at 8 cents per kw-hour, while the telephone rates will be one cent a call, with a maximum rate of $15 for residence and $25 for business telephones.

OTTAWA, ONT.—The contract between the city of Ottawa and the Ottawa Electrical Company for the lighting of the streets has been cancelled by the city, formal notice to that effect being served by the city clerk. This move however, will really not be effective till two years hence. When the contract for street lighting was entered into in the summer of 1904, provision was made that the city should have the right at any time to cancel the contract, but such cancellation would require two years notice. Some time ago a resolution was passed in council to give such notification and subsequently this action was ratified by by-law, the final reading of which was given at the last council meeting.

MONTREAL, QUE.—The Jamaica Light & Power Company, of Montreal, has been incorporated at Ottawa, Ont., with a capital of $250,000. The incorporators are: James Hutchinson, C. J. Fleet, of Montreal; G. W. Webster, of Westmount, and others.

MONTREAL, QUE.—A proposition for a municipal electric light and power system has been forwarded to the city clerk by Mr. Charles Brandeis, electrical engineer, which he claims would result in a saving to the city of $60,000 a year on 2,000 lamps, or enough to pay the whole cost of the plant ($600,000) in ten years.

The Electric Railway.

CARROLTON, GA.—The Board of Trade has met the demands of the Chattahoochee Valley Railroad Company (electric), the road being projected into Carrolton from Columbus via the million dollar electric power dam of the North Georgia Electric Company, to be built on the Chattahoochee River. The demands for a $500,000 factory were also met and committees put in charge of both undertakings.

OTTUMWA, IOWA.—Negotiations are said to have been closed for the sale of the stock of the Ottumwa Traction & Light Company to H. M. Byllesby & Co., of Chicago. The transfer involves $400,000 or $500,000.

AUGUSTA, ME.—Articles of association have been filed with the State Board of Railroad Commissioners for the Portland & Brunswick Extension Railway. The purpose is to construct a street railway between Yarmouth, Cumberland, Falmouth and Portland, a distance of 12 miles. The capital stock is $480,000. The directors are: E. J. Lawrence, A. B. Page, S. A. Nye and Amos F. Gerald, all of Fairfield, and Cyrus W. Davis, of Waterville.

SYRACUSE, N. Y.—The directors of the Rapid Transit Railway Company have re-elected the following officers. Horace E. Andrews, of Cleveland, president; William K. Vanderbilt, Jr., first vice-president; John J. Stanley, of Cleveland, second vice-president, with duties of general manager; T. H. Conderman, of Philadelphia, secretary and treasurer. John E. Duffey continues as superintendent. The contract for the erection of the new substation has been let to the Westinghouse Electric Company. Contracts call for the delivery of Niagara power for use on the rapid transit system by March 1. Vice-President John J. Stanley says that about $100,000 will be spent on the transforming station, equipment and change of lines.

MORGANTOWN, W. VA.—Surveys are completed for the Morgantown & Dunkard Valley Railroad, and contracts are soon to be let for construction. The road will be 42 miles long. It has been decided to use the single-phase system, but as yet the exact location of the power house has not been finally settled. The officers of the company are: L. L. Thomas, of Blacksville, W. Va., president; D. C. Hoffman, of Morgantown, vice-president and acting general manager; W. W. Smith, of Morgantown, secretary and purchasing agent; Sanford Barrickman, of Pedler, W. Va., treasurer; Prof. C. R. Jones, electrical engineer.

New Industrial Companies.

THE NATIONAL SWITCHBOARD COMPANY, of New York, has been incorporated with a capital stock of $50,000. The directors are J. F. McGuire, G. B. Garrison and T. V. Devins, New York.

THE LOCK-SWITCH MANUFACTURING COMPANY, of New York, has been incorporated with a capital stock of $25,000. The directors are W. O. Courtland, D. J. Newland and W. P. Hammond, New York.

THE ELECTRIC CONFECTION COMPANY has been formed in Boston, Mass. Capital, $50,000. Treasurer, Leon B. Paton, Danvers. Directors, as above and Frank W. Few, Thornton Parker and Fred S. Kingsley, of Boston, and Chas. R. Bennison, of Winthrop.

THE TELEGRAPH NEWS COMPANY has filed an application of incorporation at St. Louis, Mo. The capital stock is $10,000, one half paid. The incorporators are John M. Grant, of Orange, N. J.; Courtland Smith, of Dobbs Ferry, N. Y.; Wm. L. Vail, of Fairview, N. J.; M. F. Germond, of Dumont, N. J.; Joseph Adridge, Roy D. Moore and Geo. P. Feis of St. Louis. The object of the incorporation is to manufacture, deal in, operate and maintain electrical instruments, etc., and to collect and disseminate news.

Legal.

ILLEGAL ELEVATED TRACK.—The Appellate Division of the Supreme Court decided that the third track of the Ninth Avenue Elevated, New York City, was illegally erected, and direct that the Manhattan Railway Company is bound to compensate the property owners along the route for easement damages. Several hundred such cases are pending. The third "express" track is an absolute necessity to hundreds of thousands of people living in upper New York and doing business downtown.

DAMAGE FROM ELEVATED.—A. P. Loring, owner of the Albany Building, sued the Boston Elevated Company for $150,000 because trains passing around the corner of the building caused annoyance. A phonograph was brought into court to reproduce the noise made by the trains as they passed. A photometer was also used to show the diminution of light due to the erection of the elevated structure, and an oscillometer showed photographs of the air waves disturbed during the passing of a train. A verdict of $45,000 was given with interest, the total making $58,267.

DRY BATTERY INJUNCTIONS.—The Columbia Dry Battery Company and the Vim Company, both of Chicago, have been enjoined from the sale of their "Columbia" dry batteries. Suit was brought by the National Carbon Company, claiming the "Columbia" trade mark, before Judge Kohlsaat in Chicago, with the result that on December 12 an injunction was issued against these concerns forbidding them from offering for sale any dry batteries not made by the National Carbon Company to which is applied the word "Columbia" or the words "Columbia Dry Battery Company." The effect of this injunction, we are advised by the plaintiffs, is to confirm the National Carbon Company in the possession of the trade mark "Columbia."

CABLE CONDUITS.—The Appellate Division of the New York Supreme Court handed down last week a decision in the case of the West Side Electric Co. against the Consolidated Telegraph and Electrical Subway Co. The judgment rendered by Justice Truax at Special Term is affirmed. Justice Patterson writes the opinion of the court in which Presiding Justice O'Brien and Justice McLaughlin concur, while Justice Laughlin concurs in the result. Justice Ingraham writes a dissenting opinion. The plaintiff company sought a perpetual injunction against the defendants to restrain it from interfering with or obstructing the maintenance of certain cables and electrical conductors, located in subways or ducts in the city of New York. Justice Truax dismissed the complaint, and an appeal was taken. The Appellate Division at the same time affirmed an order dismissing and quashing an alternative writ of mandamus, which had been directed to the defendant, to enforce a right claimed by the plaintiff to lay or place other cables for electric lighting purposes in subways in the city of New York. The court says: "If it be true that the right to the use of the streets is a part of the franchise of the appellant, then it results from the Glue case that the Board of Aldermen was the legislative body having the power to grant a franchise to use the streets. In the case cited it was held that previous to 1897 the Board of Aldermen was the body which had the power to confer street franchises." The same question was involved in both the action and the special proceeding, and that question was as to the right of the plaintiff company to use the subways as claimed by it. Justice Patterson says that it is conceded that it had an apparent right, insomuch as it had received the consent and authority of the Board of Electrical Control of the city of New York. The company contended that such consent was all that is required to enable it lawfully to lay, construct wires, and maintain other appropriate appliances for conducting and distributing electricity in subways under the streets, avenues, and public places in the city of New York. The defendant insisted that the authority so derived was insufficient, and that the power in question resides only in the Board of Aldermen.

Obituary.

MR. J. W. FLETCHER.—We regret to note the death of Mr. John William Fletcher, general superintendent of the Fulton County Gas & Electric Company. He died of appendicitis at the Littauer Hospital, Gloversville, N. Y., on December 12. He was only 34 years of age, and was a graduate of Lehigh University, class of 1900. He leaves a wife and one sister.

Educational.

DETROIT Y. M. C. A. is offering technical education to its members, embracing electrical work in charge of Mr. James D. McCarthy, for eleven years city electrical inspector of Detroit, and of Mr. A. J. Crane, B. S., of Purdue University. The details are set forth in circulars issued by the Association.

WESTERN UNIVERSITY OF PENNSYLVANIA.—The bulletin of the Western University of Pennsylvania states that the electrical engineering department has grown very rapidly during the last year and the equipment has been greatly improved while other improvements are still in progress. The laboratory has been enlarged, so that now it has more than twice the capacity that it had a year ago. Several new Westinghouse dynamos and motors have been added, also new portable indicating instruments, including a millivoltmeter with shunt, making it possible to measure from zero to 500 amperes. The machinery and shafting have all been rearranged and new marble switchboards are being constructed according to the latest and most improved designs. This is done so that more machinery and more apparatus can be in operation at the same time. The result is that many more students can be accommodated than ever before. A new mercury-arc rectifier has been ordered and is now being made by the General Electric Company, which will be used for charging a 56-cell storage battery and for experimental purposes. The classes in the electrical department this year are more than twice as large as they have ever been before, and to accommodate them the laboratories have to be in operation every school day in the week, and another assistant has been employed. According to the present outlook a further increase in equipment will have to be made to accommodate the still larger classes of next year.

Personal.

MR. F. P. FISH.—President Fish of the American Telephone & Telegraph Company will make a trip to the Pacific Coast in a few days for the inspection of the telephone companies in the West. He expects to be gone about three weeks.

MR. ISIDORE S. PRENNER, E. E., patent attorney and counsellor-at-law, has moved from Scranton, Pa., to the Betz Building, Philadelphia. Mr. Prenner gives advice in technico-legal cases and is a consulting engineer and electrochemist.

MR. E. MOORE, a freshman in the L. C. Smith College of Applied Science, at Syracuse University, is said to have received $5,200 from the Winton Company for a new automatic sparker for automobiles, and to have sold one or two inventions; while he has more on the way to perfection.

MR. W. S. KELLEY.—Mr. Walter Stuart Kelley, B. S., for nearly seven years in charge of the outside service, or power engineering for the Narragansett Electric Lighting Co., has severed his connection with the company and on January 1 will assume the duties of chief engineer of the Holtzer-Cabot Electric Company, of Brookline, Mass.

MR. F. S. DRAKE.—Mr. Frank S. Drake, formerly at the works of the General Electric Company, at Lynn, Mass., it is now officially announced has been appointed Assistant General Manager of the entire service of the Urban and Interurban Street Railway system of the Portland (Ore.) Railway Company. More latterly Mr. Drake has been connected with air brake interests.

MR. F. M. FARMER, of the Electrical Testing Laboratories of New York, has been at the Westinghouse works at East Pittsburg, Pa., conducting acceptance tests on a large order of electrical apparatus, including two 1,500-kw generators, nine 1,000-kw transformers, rotary converters, smaller transformers, etc., for the Grand Rapids-Muskegon Water Power Electric Company, of Grand Rapids, Mich.

MR. W. H. McGRATH succeeds A. W. Leonard as general manager of the Houghton County Street Railway Company and the Houghton County Electric Light Company of Michigan. Mr. McGrath went to the copper country from the east to take a position under Mr. Leonard. With the appointment of Mr. Leonard to the position of general manager of the two local companies of Stone & Webster, Mr. McGrath was made superintendent of the electric light work. He has held that position since. Mr. McGrath's promotion meets with general approval on the part of the copper country patrons of the two corporations, and he is in receipt of many congratulations.

MR. C. H. B. CHAPIN has recently resigned from the New York Edison Company as manager of one of the branch offices in the Contract and Inspection department; prior to which he was manager of the Complaint department. He has now opened an office at 1170 Broadway, New York City, and is prepared to do general consulting engineering work, making a specialty of two lines that may be of interest to the central station manager. These are the developing of up-to-date methods of selling electricity, inclusive of advertising, and contracting to test meters on the circuits of such smaller companies as do not maintain a testing department of their own. Mr. Chapin's experience is such as to place him in a position of advantage to do this work.

DR. N. M. HOPKINS, professor of chemistry at the George Washington University, Washington, D. C., has been appointed chief electrical engineer, Bureau of Yards and Docks, U. S. Navy, and placed in charge of the electrical and mechanical engineering work at the various navy yards, with special reference to the consolidation of power plants. The position carries with it a salary of $5,000 a year. The appointment was authorized by President Roosevelt at the request of the Secretary of the Navy and the chief of the Bureau of Yards and Docks. The only condition was the passing of an examination before a board of experts of the Civil Service Commission. Dr. Hopkins is well known in the electrical and chemical fields as a young man of great ability and author of several books.

SIR OLIVER LODGE, in a paper read before the Psychical Society in London, advanced a strong plea for the impartial consideration of psychical phenomena. "I hold," he said, according to The London *Mail*, "that if physical metaphysical phenomena make their appearance in quantity and quality sufficient for investigation, it is the duty of our society to examine them as astronomers observe a solar eclipse or the transit of Venus. The British public," continued Sir Oliver, "is apt to consider anything relating to the Stock Exchange and horse racing as worthy of consideration, but to despise the emotions. Physhical phenomena are essentially worthy of investigation, and they will be investigated by those who feel called to the work, although they are looked at askance by some of the scientific magnates of the day."

MR. J. P. NEAVE.—The following item comes from Cincinnati in regard to one of the well-known officials and stockholders of the Bullock Electric Manufacturing Company: "The new Democratic anti-boss administration has decided to appoint Joseph S. Neave superintendent of the Street Cleaning Department. Mr. Neave is a millionaire, but announced some time ago that he would accept the place solely for the good of the city. He is an enthusiast on the subject of clean, well kept streets as necessary to the all-around advancement of a city. He says he expects to make Cincinnati known throughout the country as a model. Mr. Neave lives in a beautiful home on Grandin road opposite the grounds of the Country Club, of which he is a member. He also belongs to the Cincinnati Golf Club, the Cincinnati Automobile Club and the Good Roads Association."

MR. S. E. WOLFF.—With regard to changes at Jackson, Mich., recently noted, the *American Gas Light Journal* has the following: "At the December meeting of the Jackson Gas Company the changes in the official staff of the company were formally announced. Mr. Emerson McMillin, former second vice-president, resigned, and Mr. S. E. Wolff, former manager in this city, but now general manager of the gas, electric light and street railway properties at Saginaw, was elected to that office. Mr. Wesley Sears was chosen a member of the board of directors, and Mr. Homer M. Eaton, of Jackson, was officially made secretary and general manager of the Jackson plant. Mr. Wolff has already assumed the duties of his new position at Saginaw. The position of manager of the company's extensive properties is a responsible one, and the many friends whom Mr. Wolff has made during his stay in this city will rejoice at his deserved promotion. Mr. Eaton, his successor at the head of the Jackson Company, although a young man, has had an experience in the gas business which thoroughly qualifies him for his position."

MR. G. HERRING.—Mr. George Herring, chairman of the City of London Electric Lighting Company, well known to many Americans, has done a handsome thing in London. A cable dispatch of December 19 says: "Mr. Herring, formerly a well-known turfman, who is the chairman of several commercial companies and a big contributor to the King's hospital fund, has given the Salvation Army £100,000 with which to experiment with land colonization in Great Britain. Gen. Booth, the commander of the army, has written to the King explaining the scheme. He will select about 300 deserving urban poor and will establish each of them in a cottage, with five acres of land, farming implements, etc. All the money advanced in this way will be repayable in installments spread over forty years, after which the land will be conveyed to the holders. The scheme will thus be self-supporting. It will be controlled by the Salvation Army, which undertakes to hand over the original capital to the hospital fund in annual installments of £4,000. Any profits will be applied to extending the scheme."

Trade Publications.

CAR JOURNAL BEARINGS.—The A. C. Stiles Anti-Friction Metal Company, Baltimore, Md., has issued a well-illustrated booklet devoted to locomotive and car journal bearings.

WATT-HOUR METERS.—The General Electric Company, Schenectady, N. Y., has issued price list No. 5142, dealing with the watt-hour meters of both the direct-current and alternating-current types.

BELT-DRIVEN, DIRECT CURRENT GENERATORS.—Bulletin No. 4426, of the General Electric Company, Schenectady, N. Y., is devoted to slow and moderate speed belt-driven generators of the direct-current type.

STEAM VALVES.—The Hancock Inspirator Company, 85 Liberty Street, New York, has issued an illustrated booklet dealing with globe, angle, sixty-degree, and cross valves adapted to the highest steam pressures.

AUTOMATIC CIRCUIT BREAKERS.—Supply catalogue No. 7592 of the General Electric Company, Schenectady, N. Y., gives a complete price list of parts of type MR automatic circuit breakers for direct-current circuits.

MOTOR DRIVES.—The Electro-Dynamic Company, Bayonne, N. J., has issued circular No. 18, dealing with the application of the "Inter-pole" variable-speed motor for the driving of machine tools, blowers, pumps, fans, laundry machinery, etc.

WIRELESS TELEGRAPHY.—The Clark Electrical Engineering Company, Detroit, Mich., has issued an interesting catalogue describing the Clark system of wireless telegraphy. Numerous views are given of the instruments used with the system and of the equipments now installed.

STEAM HOISTING ENGINES.—Catalogue No. 058 of the C. W. Hunt Company, West New Brighton, Staten Island, N. Y., is devoted to steam engines for hoisting. The engines described are unusually massive in construction and especially designed for heavy duty in continuous service.

GEORGE WEIDEMANN ELEC. CO., INC., 21-27 New Chambers Street, New York, and 267 Flatbush Ave., Brooklyn, electrical engineers and contractors, have issued a neat and pretty calendar for 1906, with colored panel entitled "Debutantes." It is oblong with stiff beveled board back.

PORCELAIN INSULATORS.—The Lima Insulator Company, Lima, N. Y., has issued catalogue No. 1, describing various forms of insulators for power

transmission, street railway, electric light, telegraph and telephone lines. The transmission line insulators are constructed for operating electromotive forces as high as 60,000 volts.

VERTICAL ENGINES.—Bulletin No. 125 of the B. F. Sturtevant Company describes and illustrates vertical engines adapted to all classes of work requiring maximum power in minimum space. These engines are of the high-speed type, and when required are equipped with extension sub-bases to allow direct connection to electric generators.

UNDER FEED STOKER COMPANY, Marquette Building, Chicago, has issued a circular calling attention to the fact that the first Jones stoker in Chicago was sold to the Allis-Chalmers Company, May 1, 1893; the latest sale on its records was for 20 to the same concern for equipping five 658-hp Edgemoor boilers at the West-Allis plant.

CALENDAR.—The Indiana Rubber and Insulated Wire Company has issued an attractive wall calendar for 1906. The figures on the monthly sheets are plain and large, an important feature in a calendar, and can be easily read at a distance. The card contains a view in colors of the company's factory at Jonesboro, Ind., and the company's well-known trade mark.

SLIDE RULES.—The Eugene Dietzgen Company, 181 Monroe St., Chicago, Ill., has issued a valuable book dealing with the theory and practical application of the Mannheim and Multiplex slide rules. In addition to describing the slide rules and furnishing numerous examples of their applications, the book contains numerous conversion tables which are especially convenient when used in combination with a slide rule.

AMERICAN THOMPSON INDICATOR.—The American Steam Gauge & Valve Manufacturing Company, of Boston, Mass., has just issued a new circular on the American Thompson improved indicator with the new detent motion. The mechanism is all inside the drum, and there is no awkward attachment to fasten to the indicator when it is being used. The circular illustrates and describes the apparatus very clearly.

REFRIGERATING MACHINERY.—The De La Vergne Machine Company, East 138th Street, New York, has issued folder No. 8011, giving a few facts concerning refrigerating and ice-making machinery. Among the several illustrations, an interesting one shows a 10-ton ice machine connected through a noiseless chain drive to a direct-current motor. Illustrations are also given of 5-ton, 50-ton and 500-ton ice-making machines.

STEAM TURBINES.—The rapidity with which the steam turbine is finding its place in our industrial life is strikingly shown by a recent publication of the Westinghouse Machine Company, East Pittsburg, Pa., which gives a list of users of Westinghouse-Parsons steam turbines, showing the number and rated capacity of units, together with the aggregate rated horse power of the turbines installed when present orders are completed.

CENTRIFUGAL PUMPS.—The G. W. Price Pump Company, San Francisco, Cal., has issued catalogue C. P. No. 3, devoted to centrifugal pumps. These pumps are of the high-speed type, and have met with gratifying success, especially when direct connection to or belt driven by electric motors. Among the numerous illustrations, one of the most interesting is a 4-stage, direct-connected motor-driven pump designed for extremely high heads.

THE OTIS ELEVATOR COMPANY, New York City, has just issued to its friends and patrons a special edition of the large quarto "King's Views of New York." This handsome publication with its hundreds of pictures, is a splendid evidence of the wonderful new city built up by the modern elevator—a city of palaces and towering edifices that could not have been created without the existence and aid of the elevator. We understand that copies can be had on application.

ELECTRIC ROCK DRILL.—Catalogue No. 4 of the Marvin Electric Drill Company, Binghamton, N. Y., describes electric rock drills and the special type of generator which has been designed for operating them. The drill is of the plunger type, operated by means of two coils through which current flows alternately. The generator is a low-frequency alternator, and the drill operates in time with it, each revolution of the bipolar armature producing one complete stroke of the drill.

WATCH-CASE VOLTMETERS AND AMMETERS.—Bulletin No. 20 of the Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass., gives a complete description of the design and construction of watch-case voltmeters and ammmeters. These instruments are most convenient for testing small primary or storage batteries used for telephones, bells or the ignition circuits of gasoline motor cars. They are equally useful for physicians' batteries, or for testing single cells of large storage battery installations.

OIL-INSULATED TRANSFORMERS.—Bulletin No. 1047, of the Allis-Chalmers Company, Cincinnati, Ohio, describes Bullock transformers for indoor use. These transformers are made in two types, according to the method of cooling. Both are oil-filled, but in the oil-filled, self-cooled type the heat is carried off by radiation from the case, while in the oil-filled water-cooled type water is circulated in a coil of seamless copper or brass tubing immersed in oil, and the heat is effectively carried off. The constructional features of the transformers are well shown by numerous illustrations.

"DETERMINATION."—Pass & Seymour, Solvay, N. Y., have issued a very handsome calendar for 1906. The subject is symbolical, "Determination," implying the resolve of the concern to give only the best in porcelain electrical supplies. The upper part of the panel has in black and white embossed relief a woman holding firmly in hand a restive horse, the look of determination on the woman's face being equalled only by that on the face of the members of the company in expressing their determination to hold the trade they have won. The original of this spirited work is by Goldschrader.

NORTHERN BOX TYPE MOTORS.—There is a wide field of application of motor drive in which the conditions are extremely severe. This class of service includes crane and hoisting work. The Northern Electrical Manufacturing Company, Madison, Wis., has developed a line of box type motors. These equipments are completely enclosed and thus dust proof. They are frequently built weather proof. This class of motors has an extremely sturdy armature shaft and liberal bearings, and compact although accessible arrangement of the motor parts. Bulletin 32 is descriptive of these equipments.

CROCKER-WHEELER COMPANY, Ampere, N. J., in issuing a calendar with picture of its large alternator, say: "Our most important achievement in the year 1905 was our successful entrance into the field of alternating current manufacture. After 17 years' experience in the direct-current field (in which we continue to hold an enviable position) we entered the market with a complete line of alternating-current generators, motors, transformers, etc. In a short time, still holding our place in the direct-current field, we had established ourselves in the front rank of A. C. manufacturers. An example of our work in this line is shown on the enclosed card calendar for January, February and March."

ELECTRIC AND PNEUMATIC TOOLS.—Catalogue No. 17 of the Chicago Pneumatic Tool Company, Fisher Building, Chicago, is a handsomely arranged publication containing 192 pages of standard book size, 6 x 9 inches. All types of portable tools are illustrated and described. Five pages are devoted to air-cooled Duntley electric drills, which are claimed to have given excellent satisfaction. An indication of the growth of the portable tool business of this company is obtained from the fact that eleven years ago, when its first advertising literature was issued, a 16-page folder for enclosing in the regular 6¾ envelope was found sufficient to contain a description of all the types of tools then manufactured.

GEAR CUTTING MACHINES.—The Eberhardt Brothers Machine Company, 66 Union Street, Newark, N. J., has issued as a folder a reprint of an article from the *American Machinist* on "Some Interesting Generated Worm Gearing," which describes the machine work done by gear cutters manufactured by this company. The "generating" machine illustrated is capable of cutting teeth in a worm wheel 84 inches in diameter. Bulletin No. 1 of this company is devoted to semi-automatic gear cutting machines for spur and bevel gears, especially adapted for railway motor work. The company has also issued an illustrated bulletin dealing with its 16-in. crank shaper of the single-geared and back-geared types.

"ELECTROTHERM," A SUBSTITUTE FOR THE HOT-WATER BAG.—Folder No. 3455 of the General Electric Company, Schenectady, N. Y., describes an interesting electrical novelty in the form of a substitute for the hot-water bag. The "Electrotherm" is composed of wires insulated and protected by asbestos, woven into a light and flexible sheet or pad, which, when connected to the ordinary incandescent lamp socket, offers sufficient resistance to allow the current to produce a constant and uniform degree of heat. It is the function of the "Electrotherm" to banish the deficiencies existing in other methods of applying heat locally in bodily ailments, and to introduce refinements of treatment and comforts for the sick not otherwise obtainable.

THE CONNECTICUT TELEPHONE & ELECTRIC COMPANY, of Meriden, Conn., has issued new catalogues No. 9 and No. 10, covering long-distance and interior telephone equipments respectively. These catalogues are handsomely illustrated with half-tone cuts throughout, and go into careful detail with each line. Each issue contains many new and up-to-date specialties. The Connecticut company during the last year has been obliged to considerably increase its plant and the prospects are very bright for an even larger business during 1906. The company was organized in 1893, and has manufactured telephones and electrical specialties, and since that time has grown each year to its present large capacity. The Connecticut company will be pleased to mail its new catalogues, No. 9 and No. 10, to anyone interested.

MAGNETISM OF IRON VESSELS.—In order to a better understanding of the magnetism of iron vessels, and the compensation of the compass, as explained in many of the text books, Mr. E. W. Owens, of the Liverpool Nautical College, has prepared a little work entitled "The A. B. C. of Compass Adjustment" which purports to convey in simple language, a thorough explanation of this complex problem. It contains a number of charts and diagrams, and will be found useful for students and others in understanding the subject. The price is $2, and it is issued by D. Van Nostrand Co. Another little manual of a somewhat similar nature is to be found in "The Van Nostrand Science Series." It is entitled "Magnetism of Iron Vessels and Terrestrial Magnetism" and is by Prof. Fairman Rogers, of Philadelphia.

VARIABLE-SPEED MOTOR.—Bulletin No. 1 of the Lincoln Electric Manufacturing Company, Cleveland, Ohio, describes in detail the constructional features of the Lincoln variable-speed motor with a speed range of 5 to 1, for use on ordinary two-wire, direct-current circuits. This motor is a four-pole, shunt-wound machine, and means are provided for moving the armature out or in between the field pole pieces. As the armature is withdrawn, the magnetic reluctance increases and the magnetic flux decreases, the result being increased speed. The armature is slightly larger at one end than at the other. This conical shape is used in order to more quickly increase the air gap, which it does as the armature is withdrawn from the pole pieces; this, with the decrease in the magnetic area gives a greater variation in speed than would otherwise be possible.

CENTRAL ELECTRIC COMPANY, East Jackson Boulevard, Chicago, has just issued the 1906 edition of the well-known standard catalogue. It has 600 large pages, and is No. 24. It is replete with information, data, illustrations, descriptions, prices, etc., and includes all the very latest applications in the electrical arts. A great new feature is that wherever possible, the approximate shipping weight is given. Every article has also a code word and a number, and the cipher code enables correspondence and ordering to be carried on entirely by telegraph. Such a catalogue is an invaluable piece of equipment. The new and, we believe, unique idea of giving the shipping weight is admirable. It enables the customer to estimate the cost of material laid down in his own city, which is of considerable importance, particularly where freight rates are high, as in the West, and where shipments are frequently made up by purchasers with a view to securing a minimum rate. Those wishing to secure a copy of this trade encyclopædia should write for it at once.

AUTOMATIC RAILWAY.—The C. W. Hunt Company, West New Brighton, N. Y., has issued catalogue No. 0510, dealing with the "Hunt" elevated self-acting railway used for conveying coal from the front of a wharf to a storage bin. The operation of the railway is as follows: When a loaded

car reaches the end of its journey it has raised a counterbalance weight to a certain height, by means of a steel wire cable which the car picks up while running down the track. After the load has been automatically dumped, the impulse received by the car from the fall of this counterbalance weight is sufficient to return the empty car back up the grade to its starting point. The weight rises only a limited distance, its object being to give the car a start back, and the momentum of the car carries it the remaining distance.

SPECIAL INCANDESCENT LAMPS.—Folder No. 3375 of the General Electric Company, Schenectady, N. Y., gives an illustrated description of electric decorative lighting outfits, which are especially advantageous for use during the holiday season. Bulletin No. 4424 of the same company deals with incandescent lamps for steropticons, magic lanterns, projectors, head lights, etc. These lamps are provided with special helical filaments which serve to concentrate the light in the desired direction.

TANGENTIAL WATER WHEELS.—The Abner Doble Company, San Francisco, Cal., has issued as bulletin No. 7 the first comprehensive catalogue relating to its hydraulic products. The first portion of the catalogue contains general matter descriptive of the essential features and parts entering into the construction of Doble tangential water wheels, special attention being paid to the Doble needle regulating nozzles, ellipsoidal buckets, ring-oiling bearings, nickel-steel shafts, etc. Illustrations of several of the different types of water wheels are followed by descriptions of some of the typical hydro-electric power plants in which these wheels are operating. Descriptions are given of the 8,000-hp wheels which were constructed for the de Sabla and Electra Power Houses, and of a 9,000-hp wheel which is now being built. The water wheels installed in the Mill Creek No. 3 power plant of the Edison Electric Company, Los Angeles, Cal., are remarkable for the high head under which they are used, namely 1,960 feet. The description given of the plant at Cornell University is of interest as showing the high efficiency of 84.5 per cent obtained with the Doble wheels operating under a head of 134 feet. The latter portion of the book contains the Doble water-wheel tables, covering all conditions of water power up to a head of 2,550 feet, and in capacities up to 5,000 horse-power. Other tables relate to the loss of head in pipe by friction, riveted steel pipe, etc., and four pages contain useful hydraulic information. The last seven pages are devoted to a series of ready conversion factors, most of which have been compiled from a recent work by Mr. Carl Hering. The catalogue is not only instructive in respect to the particular line of high-grade tangential water wheels, but it is also of value to an engineer as a handy reference book on hydraulic engineering.

News of the Trade.

THE CHICAGO PNEUMATIC TOOL COMPANY, Fisher Building, Chicago, has been awarded the gold medal at the Liege Exposition for pneumatic tools and appliances, and the silver medal for Franklin air compressors. The company states that it has always received the highest honors since its first exhibit made at the Cotton States Exposition at Atlanta, Ga., 1895.

THE GREGORY ELECTRIC COMPANY, of Chicago, reports business exceptionally good, and owing to a great increase in its business will remove its general offices, sales department, and works to 16th and Lincoln Sts., Chicago, where this company has its own grounds and buildings, as previously noted in this journal. A large addition is being built to the warehouse and the office space is being very materially enlarged. These improvements will be completed about March 1 and the company will then be in an exceptionally fine condition to handle its increasing business. This location is in the heart of the manufacturing district of Chicago. The Gregory Electric Company has its own sidetrack on the lines of the C., B. & Q. R. R., and has direct connection with all the railroads entering Chicago.

THE STURTEVANT SHOPS.—A visitor to the new works of the B. F. Sturtevant Co., at Hyde Park, Mass., is particularly impressed by the amount of equipment of the company's own manufacture. Beginning with the power plant, the mechanical draft fans, economizer, feed pumps, engines, generators and exhaust heads are all of Sturtevant make. Throughout the shop the tools are driven by Sturtevant motors, as well as the cranes, hoists and elevators. The heating systems entire, the blowers for the cupolas and forges in the foundry and blacksmith shops and the forges themselves are all standard Sturtevant goods. Many other parts of the equipment were made by the company, but mainly as special designs not listed in its regular products, such as bench leg castings, special cranes and trolleys and a complete works railway system with several types of special cars in the foundry.

THE ENGINEERING AGENCY, of Chicago, is undergoing a thorough reorganization and expansion. Mr. A. G. Frost, who has been at the head of the organization for four years as secretary and manager, has been elected vice-president and treasurer; Mr. R. D. Smith, who also has been with the company for a number of years, second vice-president and general manager, and Mr. Paul W. Herring, secretary. It is the plan of the agency to start offices immediately in Pittsburg, New York and Denver, in addition to the present offices in Chicago. Experienced engineers will be placed at the head of each office and of every individual department, which will enable employers to depend upon the selection of the agency for competent technical assistants. Remarkable advance in the filling of high-grade positions paying from $2,000 to $5,000 a year has been shown. In the last week of November, 1905, the agency filled 90 positions, ranging from $20 to $75 per week, including managers, superintendents, engineers, draftsmen, etc. In the month of November it filled 283 positions; in the last 13 years over 10,000 technical positions. These positions have been with the leading industrial, railroad and mining companies of the country, and the bureau in its weekly bulletin lists 250 technical positions that are open.

THE STERLING ELECTRIC COMPANY, of Lafayette, Ind., reports the last six months as among the most prosperous in its history in a business way, which shows that the independent telephone field is still prospering, while it also indicates a constantly growing and well deserved recognition of Sterling merits. Not only have there been large orders for magneto-drop, magneto-lamp-signal and central battery switchboards, but constantly increasing sales of telephones, condensers and its well-known and widely recognized protective devices. As an indication of the wide demand for Sterling protective apparatus, it has on hand at the present time, several orders aggregating over 100,000 pieces each. As exchange managers are finding a profitable business in catering to the installation of private branch exchanges, there comes a demand for a compact or convenient switchboard. The Home Telephone Company, of Toledo, O., among the leaders in this class of work, has recently equipped some of the largest hotels and office buildings in that city with the new cordless board, designed especially for small exchanges of this kind. This cordless board can be set conveniently upon an ordinary desk table or even attached to the wall without the attending annoyance of cutting the table for the accommodation of cords and weights, while the absence of cords (always a weak point in the circuit) eliminates a frequent trouble, all connections being made by cams or plungers.

ECONOMY IN STEAM PRODUCTION.—Every engineer knows that a large amount of heat passes into the atmosphere in the smoke and waste gases. By transferring a portion of this heat to the feed water, the boilers supply a larger quantity of steam and the coal bill is reduced to a minimum. With chimney draft only a comparatively small amount of heat can be taken from the gases, for high temperature is necessary to the production of sufficient draft. In an installation including mechanical draft apparatus, however, a large economizer can utilize much more of this heat, for the fan will maintain the desired draft intensity regardless of the temperature. It is this combination which the B. F. Sturtevant Company, Boston, Mass., some years since developed as presenting the greatest opportunity for further economy in steam production. To abstract the greatest possible quantity of heat, the pipes of the Sturtevant economizer are "staggered"; that is, the pipes of one section are placed opposite the spaces of the adjacent section so that by presenting a continuous wall of pipes the currents of hot gases are thoroughly broken up and made to impinge on the pipes containing the cold water. This arrangement gives a high efficiency and results in a saving of 10 to 20 per cent in fuel, and an increase in capacity varying from 20 to 40 per cent according to conditions. It always maintains a large volume of hot water ready for immediate use. While the fan produces the draft in a more positive manner than the chimney, the latter is of course available for use in connection with the economizer. In fact, great possibilities of saving are present in many old plants equipped with chimney draft.

Weekly Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DEC. 19, 1905.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

807,431. ELECTRIC CONTROLLING MECHANISM FOR RAILWAY APPLIANCES; Walter J. Bell, Los Angeles, Cal. App. filed June 3, 1905. The trolley wire has connections with a pair of bell crank levers which support between them a tightly stretched wire or a cord. When a car passes, the usual conductor is slightly borne upward by the trolley wheel and imparts a motion to the bell crank levers which causes their connected wire to sag and make contact with a plate on the car.

807,434. CASING AND TERMINAL BLOCK FOR ELECTRICAL MEASURING INSTRUMENTS; William M. Bradshaw, Wilkinsburg, Pa. App. filed Mar. 17, 1905. Adapted to watt meters of the class employing a cylindrical casing. A vulcanite block with a curved wall is adapted to be secured to the inside of the casing by a single screw connection, and has sockets containing binding posts for the reception of the terminal wires.

807,464. POCKET INDUCTION COIL; Paul Hoffmann, Charlottenburg, Germany. App. filed Jan. 6, 1904. A cylindrical casing having an induction coil at one end and a dry battery at the other. The secondary terminals are connected to rings on the opposite ends of the casing so that shock may be administered by grasping the casing in the two hands.

807,477. TROLLEY; Allen P. Lord, Bradford, Pa. App. filed Jan. 9, 1905. A pair of arms having inturned extremities are counter-balanced so as to normally close over and hold the usual conductor within the groove of the trolley wheel. The arms are permitted to swing downward for the purpose of passing obstructions.

807,491. PROCESS OF MANUFACTURING NITRIC ACID; Harry Pauling, Brandau, Austria-Hungary. App. filed April 2, 1902.

807,497. BINDING POST; Henry E. Reeve, Brooklyn, N. Y. App. filed Mar. 6, 1905. Comprises a metallic arched portion with outwardly and oppositely extending legs carried thereby. The arched portion has a clamp screw which may bear the wire against the base plate.

807,520. CONTROLLER; Ferdinand Volk, Pittsburg, Pa. App. filed Feb. 4, 1905. The usual controller has detents upon its upper surface with which a dog upon the controller arm engages at the successive notches. The handle must be slightly turned independently of the arm in order to release the dog and pass to the next notch.

807,521. ICE-CUTTING DEVICE; Frank Walker, Los Angeles, Cal. App. filed May 22, 1905. A rectangular frame is strung with tightly stretched resistance wires forming rectangles therein so as to melt through a block of ice when heated by an electric current.

807,528. TRANSMITTER AND TRANSMITTER-ARM CONNECTION; Ernest E. Yaxley, Chicago, Ill. App. filed March 18, 1901.

807,545. ALTERNATING-CURRENT REGULATOR; Giorgio Finzi, Milan, Italy. App. filed Feb. 11, 1904. (See Current News and Notes.)

807,568. PRESSURE GAGE; William N. Mitchell, Chicago, Ill. App. filed Dec. 3, 1904. The pointer of the pressure gage has a spring blade at its extremity which contacts with circuit-closing pins within the gage at certain positions corresponding to predetermined pressures.

807,574. TIMING DEVICE; Hervey H. McIntire, South Bend, Ind. App. filed Aug. 3, 1903. A dash pot on a large scale arranged to break the arc light circuit of a photograph machine at its limit of movement. The fluid flow is controllable so as to vary the timing of the device.

807,575. MEANS FOR RESTORING RING-OFF DROPS FOR SWITCHBOARDS; Ewing McLean, Greencastle, Ind. App. filed Nov. 21, 1904. A trip lever is supported beneath the usual table of the switchboard so as to be engaged by the spring jack when the latter is drawn to its normal position by the usual spring or counterweight.

807,590. RAILWAY SIGNAL REPEATOR; Frederick B. Wiegand and William V. Moak, Utica, and Francis B. Harrington, Menands, N. Y. App. filed July 15, 1905. Comprises a pair of magnets and means whereby an indicator is moved to separate position dependent on the energization thereof, and to a third position when the magnets are simultaneously energized.

807,596. TELEPHONY; Edward A. Buell, Dekalb, Ill. App. filed Oct. 6, 1904.

807,626. SIGNAL-SWITCH; George H. Manners, Murray, Neb. App. filed March 2, 1905.

807,640. MANUFACTURE OF HYDROCHLORIC ACID; Isaiah L. Roberts, Brooklyn, N. Y. App. filed June 25, 1895.

807,645. RAILWAY SIGNALING; Samuel D. Strohm, Philadelphia, Pa. App. filed Aug. 29, 1891. Has means within the engine cab, the circuit of which is completed by contact springs upon the engine for indicating the number of trains within a block section. There are also automatic means for clearing the signals when all the trains have left the block section.

807,653. TROLLEY FOR ELECTRIC RAILWAYS; Walter J. Barron, Brooklyn, N. Y. App. filed June 6, 1900. A V-frame is supported by the harp so as to be swung up and guide the wheel on the wire under the influence of the trolley-cord tension.

807,656. RAIL BOND; Leonard B. Buchanan, Woburn, Mass. App. filed Nov. 30, 1904. Comprises a pair of caps which may be placed over the terminals of the usual rail bond and filled with solder so as to make an additional connection.

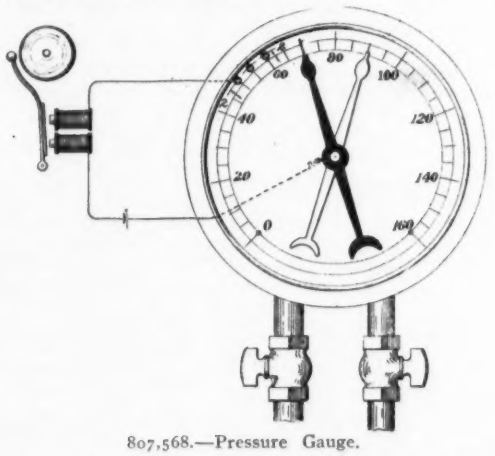
807,671. COMBINED SOCKET AND PLUG FOR INCANDECENT LAMPS; Henry W. Gremmels, Denver, Col. App. filed January 3, 1905. A plug and lamp socket from a single device, auxiliary conductors being connected with the lamp circuit between it and the main socket.

807,673. X-RAY TUBE; Emil Gundelach, Gehlberg, Germany. App. filed Dec. 16, 1904. The anti-cathode is water-jacketed so as to keep it from becoming unduly heated.

807,684. CIRCUIT CONTROLLING DEVICE; Gwynne E. Painter, Baltimore, Md. App. filed July 18, 1903. A hollow arm is adapted to be rocked by an electro-magnet and has fluid therein which flows slowly through the arm when the latter is rocked so as to overbalance the arm after a certain interval of time and restore it to its original position.

807,707. ELECTRIC RAILWAY SIGNAL; Henry A. Ammann and Albert D. Campbell, Spokane, Wash. App. filed Oct. 1, 1904. A box or casing is supported between two closely adjacent insulators and has a depending finger adapted to be moved by the trolley wheel and actuate signal circuit controlling switches within the box.

807,718. THERMOSTAT; Peabody A. Brown, Denver, Col. App. filed March 20, 1905. The usual thermostat arm of closely-connected dissimilar metals, makes signal circuits for its extreme positions in the usual way. It also has a small connected indicating pointer which moves over a dial to show the position of the thermostat arm.



807,568.—Pressure Gauge.

807,781. FUSE PLUG; Joseph Sachs, Hartford, Conn. App. filed Dec. 19, 1903. The usual threaded shell is made in the form of a cup and has a fuse wire axially connected therein which projects into position to engage the usual central stud.

807,747. INSULATING CASING FOR WIRE CONNECTIONS; Louis A. Kling, Elizabeth, N. J. App. filed May 27, 1904. A separable and detachable insulating casing applicable to straight and angular connections.

807,800. ELECTRIC RAILWAY SIGNALING APPLIANCE; Henry A. Ammann and Albert D. Campbell, Spokane, Wash. App. filed April 6, 1905. A box supported above the trolley wire has two independent levers controlling separate switches which are respectively engaged and moved by a central depending finger when the latter is swung in one direction or the other by the trolley wheels of passing cars.

807,805. RAILWAY SIGNALING SYSTEM; Henry Bezer, New Rochelle, N. Y. App. filed May 25, 1903. A complete railroad signal system relating particularly to the means for electrically interlocking the various operating levers within the switch tower.

807,829. RAILROAD SIGNALING; Isidor Kitsee, Philadelphia, Pa. App. filed Oct. 14, 1905. A contact finger is carried at the extreme forward point of the fender of a train so as to ring an alarm circuit within the cab in case the rails are short circuited by a preceding train before the following train has sufficiently advanced to itself short circuit the rails.

807,847. LIGHTNING ARRESTERS; Ernest S. Moorer, Anderson, S. C. App. filed May 9, 1905. The incoming wires are led spirally around a pair of parallel blocks between which is supported a toothed ground connection. The lightning discharges jump from the spiral turns to the teeth of the ground connection.

807,858. CONTROLLER FOR ELECTRIC MOTORS; William A. Paris, Edgewood Park, Pa. App. filed Apr. 3, 1905. An oil bath controller in which the central controller shaft is threaded throughout its length and under certain circumstances may be clutched so as to lower the casing or tank and expose the drum for inspection.

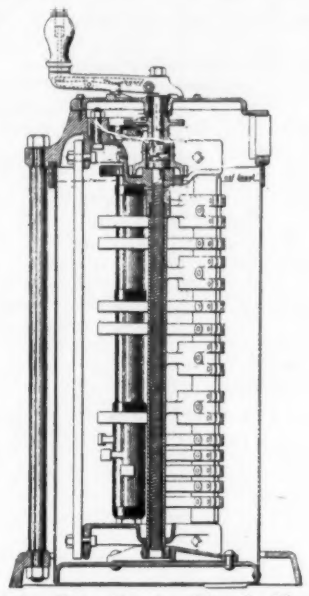
807,859. ANNUNCIATOR; Jane and William Patten, New York, N. Y. App. filed Apr. 5, 1905. Four aligned solenoid coils actuate a pair of annunciator indicators and are so connected by single switching means as to give proper up and down indications for an elevator.

807,860. ELECTRIC HAND LAMP CONTACT; George L. Patterson, New York, N. Y. App. filed Dec. 30, 1904. The push button on the side of the cylindrical casing of the usual hand incandescent lamp can be slid longitudinally so as to be retained in circuit closing relation.

807,870. POLE CHANGING DEVICE; Harry O. Rugh, Chicago, Ill. App. filed June 2, 1902. Provides a pole changing switch operated by electromagnetic means and associated with an agency that will only cause its actuation during the time the operator's ringing key is employed for calling subscriber.

807,871. ELECTRIC SELF-PLAYING VIOLIN; Henry K. Sandell, Chicago, Ill. App. filed Mar. 27, 1905. A bank of magnet operated stops are held above the strings of the violin so as to give the different tones and a plurality of rotating rosin covered wheels may be independently contacted with the strings so as to induce the vibrations therein.

807,885. THERMAL CUT-OUT; Theodore Varney, Pittsburg, Pa. App. filed Jan. 3, 1905. A porcelain casing has a central threaded core between the threads of which is spirally wound the slender wire constituting the fusible element.



807,858.—Controller for Electric Motors.

807,930. APPARATUS FOR TREATING HIDES; Frank B. Hinkson, Newcastle, Pa. App. filed Dec. 27, 1904.

807,937. ELECTRIC-MOTOR CONTROLLER; Henry D. James, Pittsburg, Pa. App. filed April 3, 1905. (See Current News and Notes.)

807,938. CONTROL SYSTEM FOR ELECTRIC MOTORS; Henry D. James, Pittsburg, Pa. App. filed April 3, 1905. (See Current News and Notes.)

807,939. CONTROLLER FOR ELECTRIC MOTORS; Henry D. James, Pittsburg, Pa. App. filed April 3, 1905. The controller arm is arranged to swing through an angle of about 120° and to produce successive rotations of the controller drum through angles of 180° always in the same direction.

807,943. REGULATING MEANS FOR SYSTEMS OF ELECTRICAL DISTRIBUTION; Benjamin G. Lamme and Charles F. Scott, Pittsburg, Pa. App filed Feb. 1, 1905. (See Current News and Notes.)

807,949. MAGNETO-ALTERNATOR; Leon Jules Le Pontois, New Rochelle, N. Y. App. filed Oct. 20, 1904. The field magnet consists of a permanently magnetized ring formed of a continuous steel ribbon.

807,960. SYSTEM OF ELECTRICAL DISTRIBUTION; Roderick M. Palmer, Cambridge, Mass. App. filed Dec. 22, 1904. A system for reducing 110-volt circuit for the operation of bells, etc., within a house, comprising magnet-operated switches which throw resistances into circuits with the bells, etc.

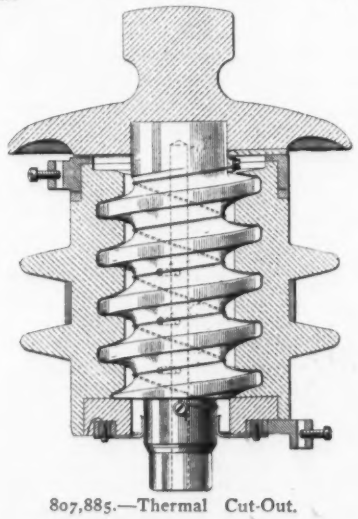
807,962. CARBON PLATE FOR PROTECTICE DEVICES; Greenleaf Whittier Pickard, Amesbury, Mass. App. filed April 14, 1904.

807,963. PROTECTIVE DEVICE; Greenleaf Whittier Pickard, Amesbury, Mass. App. filed Dec. 21, 1904.

807,964. APPARATUS FOR PRODUCING OZONE; William P. Rice, Chicago' Ill. App. filed May 9, 1904.

807,973. PROCESS OF OBTAINING MARKETABLE ELECTROLYTIC DEPOSITS; Pierrre Steenlet, Brussels, Belgium. App. filed Nov. 7, 1903.

807,984. ELECTRIC RAILWAY; Frank Adams, North Adams, Mass. App. filed Jan. 30, 1904. The wheels of the car contact with a shoe which is effective to move a switch for energizing the third-rail section immediately ahead of the car.



807,885.—Thermal Cut-Out.

808,016. ELECTRIC CLOCK; Loren C. Cox, Quincy, Ill. App. filed July 6, 1905. The driving means of the clock comprises a weighted arm which is intermittently raised by magnet-controlled ratchet and pawl mechanism.

808,022. AUTOMATIC CUT-OUT FOR ELECTROPNEUMATIC BRAKES; Edward H. Dewson, Edgewood Park, Pa. App. filed Apr. 19, 1905. A system for economizing electric power in installations where the air brakes are operated by a pilot circuit. The circuit, which is completed to release the brakes, is automatically broken when the train pressure comes up to normal.

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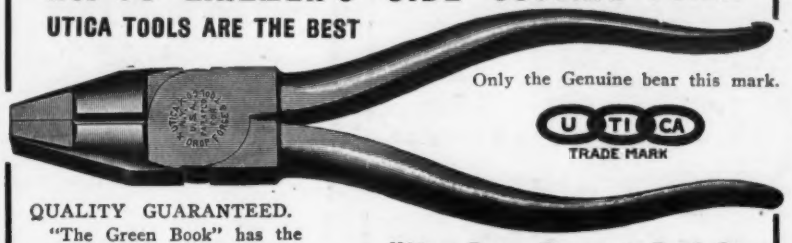

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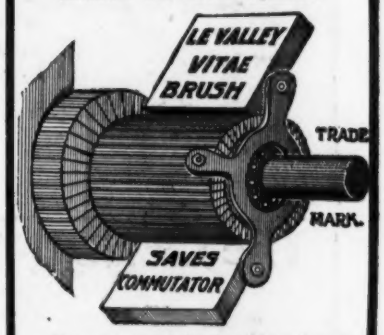

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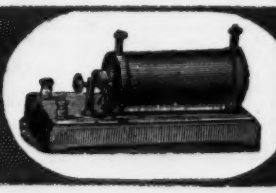

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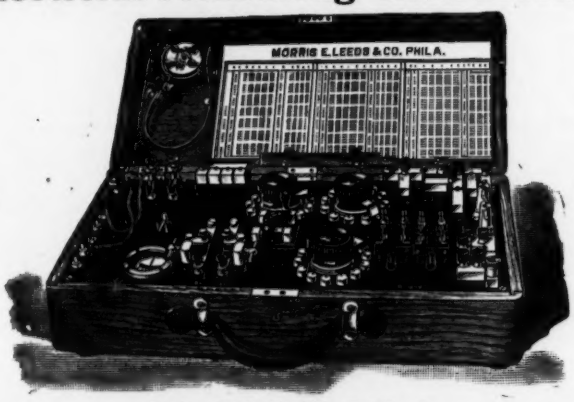

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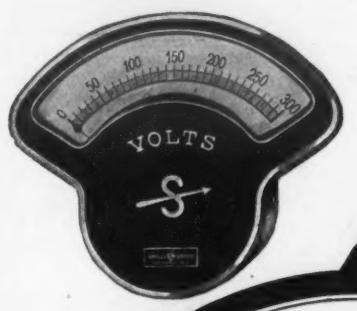

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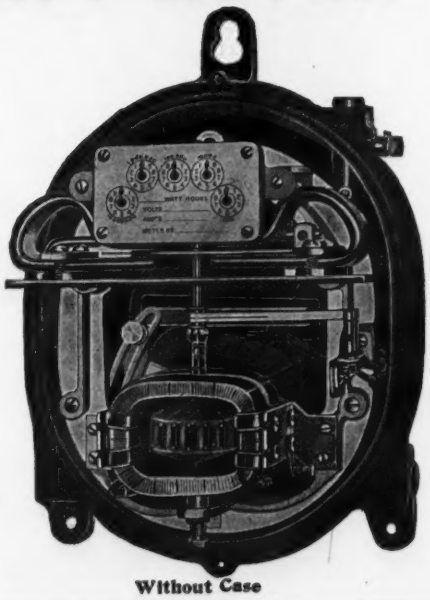

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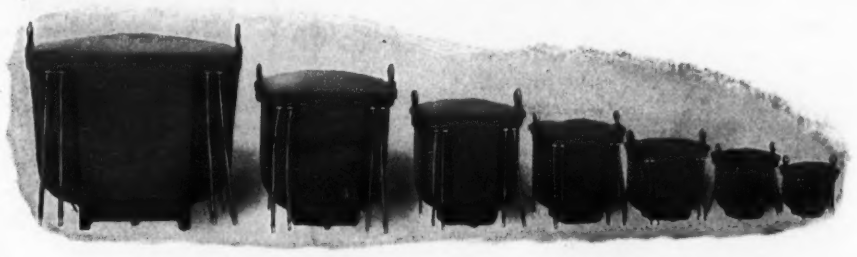

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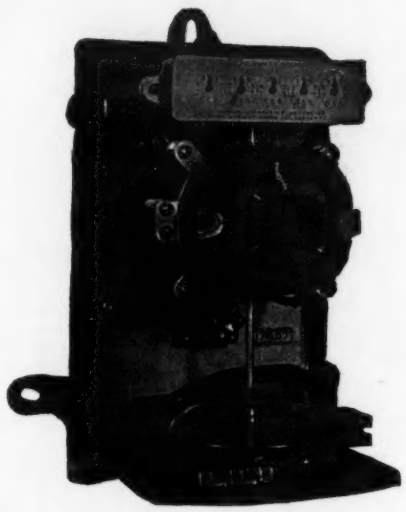

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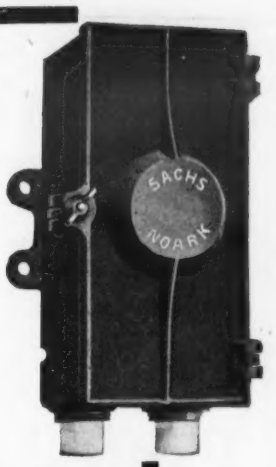

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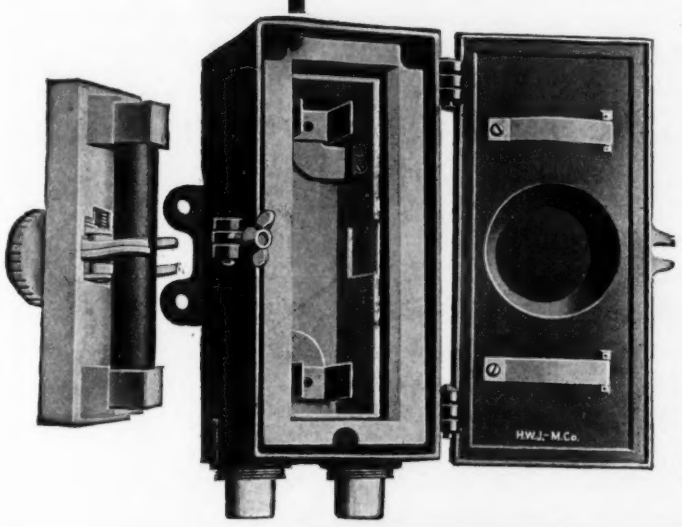

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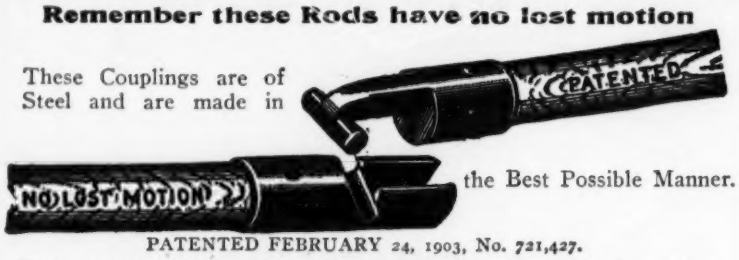

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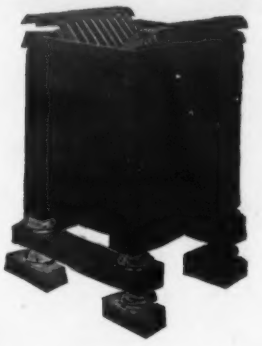

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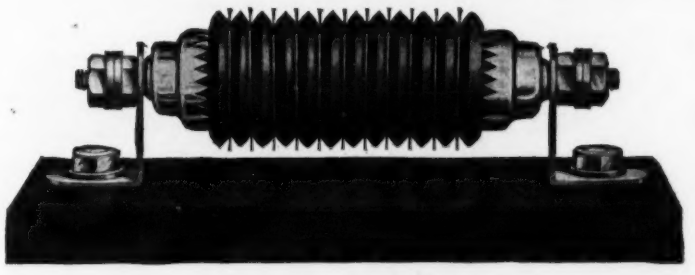

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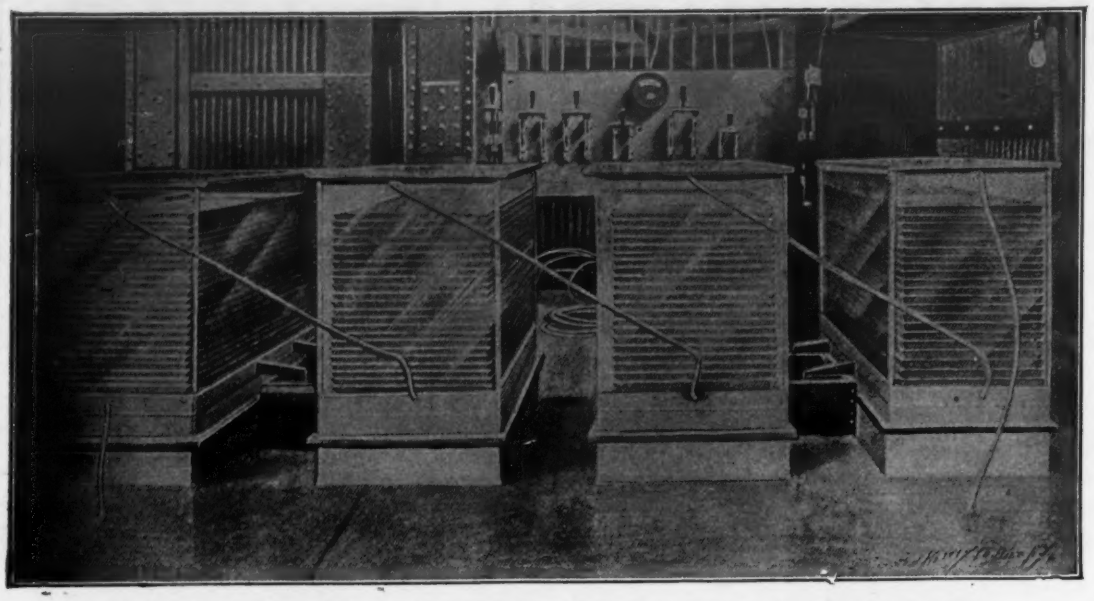

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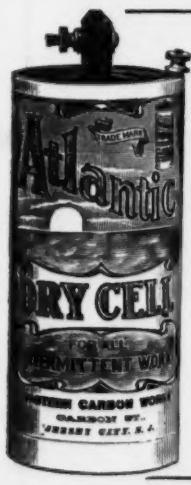

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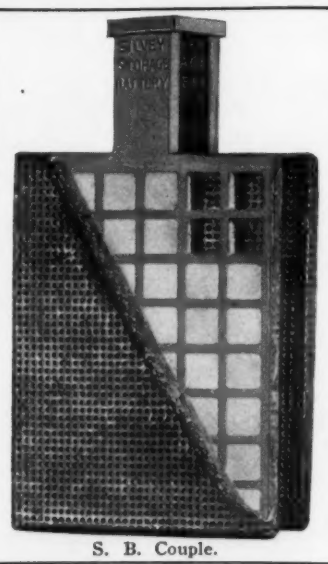

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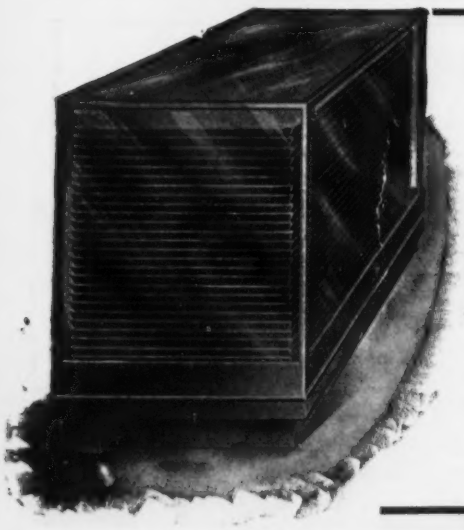

The Electro-Chemical Tray Battery

is unequaled for stationary work because it can be placed anywhere without inconvenience from corrosive or stifling vapors; will deliver full rated current for 8 and often 10 hours at 2 volts per cell. Needs no cleaning, being protected from dust; active material cannot be dislodged, and sediment, if present, can do no harm. Let us tell you more about it. The subject is important to all battery users.

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"Unit Accumulator"
PATENTED JAN. 11, 1905
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most closed circuit primary cells is costly and bothersome.
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Safer, cleaner and less expensive than with alcohol or other methods. It connects to any incandescent lamp socket and operates quickly by turning the switch.
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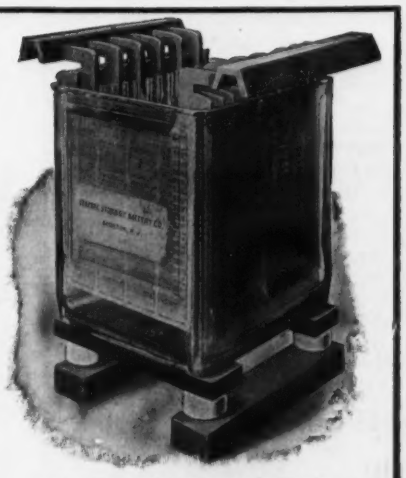
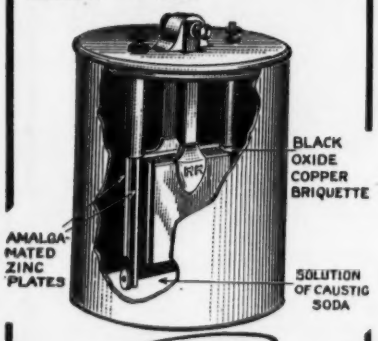


Size F 13 Plates in Glass Tank
Bus Bar Connection

ON PRIMARY BATTERIES—Voltage

One type of battery is now universally used for all hard continuous service, such as the operation of railway semaphore and crossing signals, to the exclusion of other types. In this cell the electrodes are of zinc and copper, with a solution of caustic potash and copper oxide for the depolarizer. It has been chosen over all other types because it has a capacity per unit weight greater than any other, either primary or secondary, and the voltage and current keep up to full value until the battery is entirely exhausted. However, the last point does not hold for even all batteries of the copper oxide type, for in many of them the copper oxide, which is a poor conductor of electricity, is loose or does not cover the whole surface of the negative electrode, or is *mixed with foreign matter*, or is one of the lower oxides of copper and not the black oxide.

When current is drawn from a battery possessing any one of these defects the voltage will fall, on account of the deposit of hydrogen on the negative electrode, and for the same reason the Internal Resistance will Rise.



TRADE MARK
Thomas A Edison

In one type of battery these defects have been avoided; we quote from Carhart's "Primary Batteries": "Recognizing the good qualities of copper oxide as a depolarizer, EDISON has devised a form designed to meet the objections noted above. The copper oxide is employed in the form of a compressed slab, which, with its connecting copper support, serves also as the negative plate. In recent cells the device has been resorted to of reducing a superficial film of copper on the oxide before it is sent from the factory."

The effectiveness of this method was demonstrated in a recent test by the D., L. & W. R. R. of equal numbers of EDISON and two other selected makes of copper oxide cells operating a Union signal. At the beginning each battery read 8.5 volts. The Edison made 65,451 signal movements and then gave 8.1 volts; the next best battery made 65,445 movements, but the voltage dropped to 7.75, while the third made 63,535 movements and dropped to 7.25 volts. The difference is enough to make it pay to get the best.

Send for further details of this test and for our BOOK "AR."

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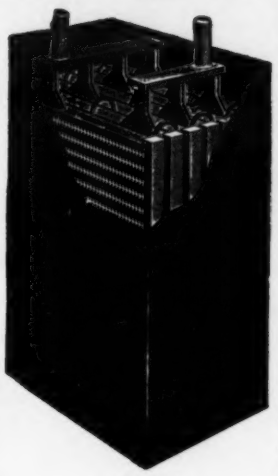
THE NEW "MORRISON" STORAGE BATTERY

Just What the World Has Been Waiting For



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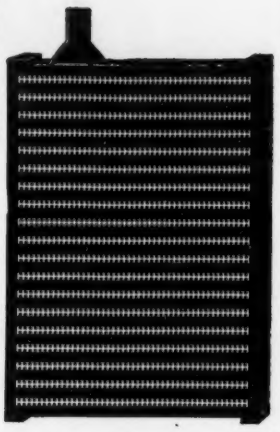
This plate is so strong electrically and mechanically that no amount of electrical abuse or of vibration in traction service can dislodge even the slightest particle of its active material.

Lowest internal resistance of any storage battery in the world.

The weight efficiency is conservatively 14 watts per pound total weight, and electrical efficiency unsurpassed.



THE PLATE

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are divided into two classes — open circuit and closed circuit.

There should be two more divisions—those that work and those that don't.

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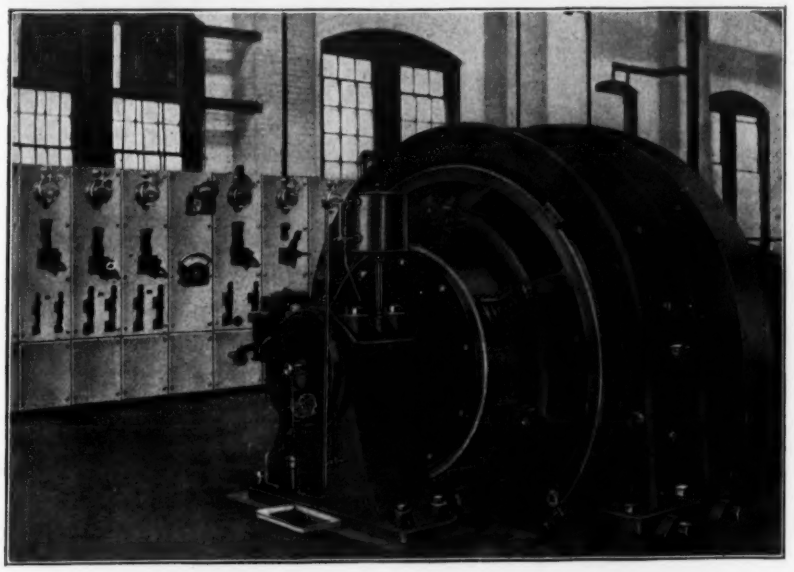

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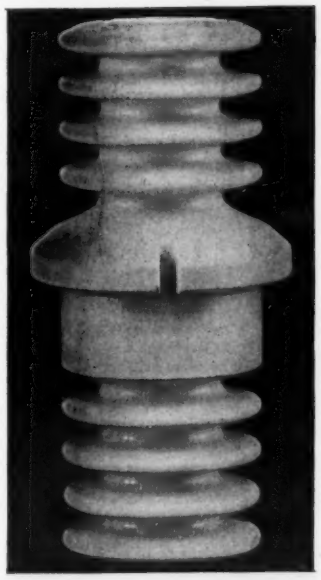

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facilitates construction, being shipped assembled; the braces swing upward into the plane of ring. Another novel idea is the pole-cap which, when placed over top of pole, protects that susceptible portion from the weather and holds ring in position until braces are securely attached.

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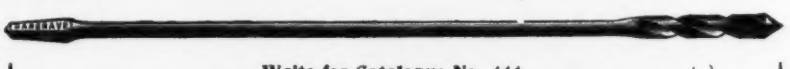
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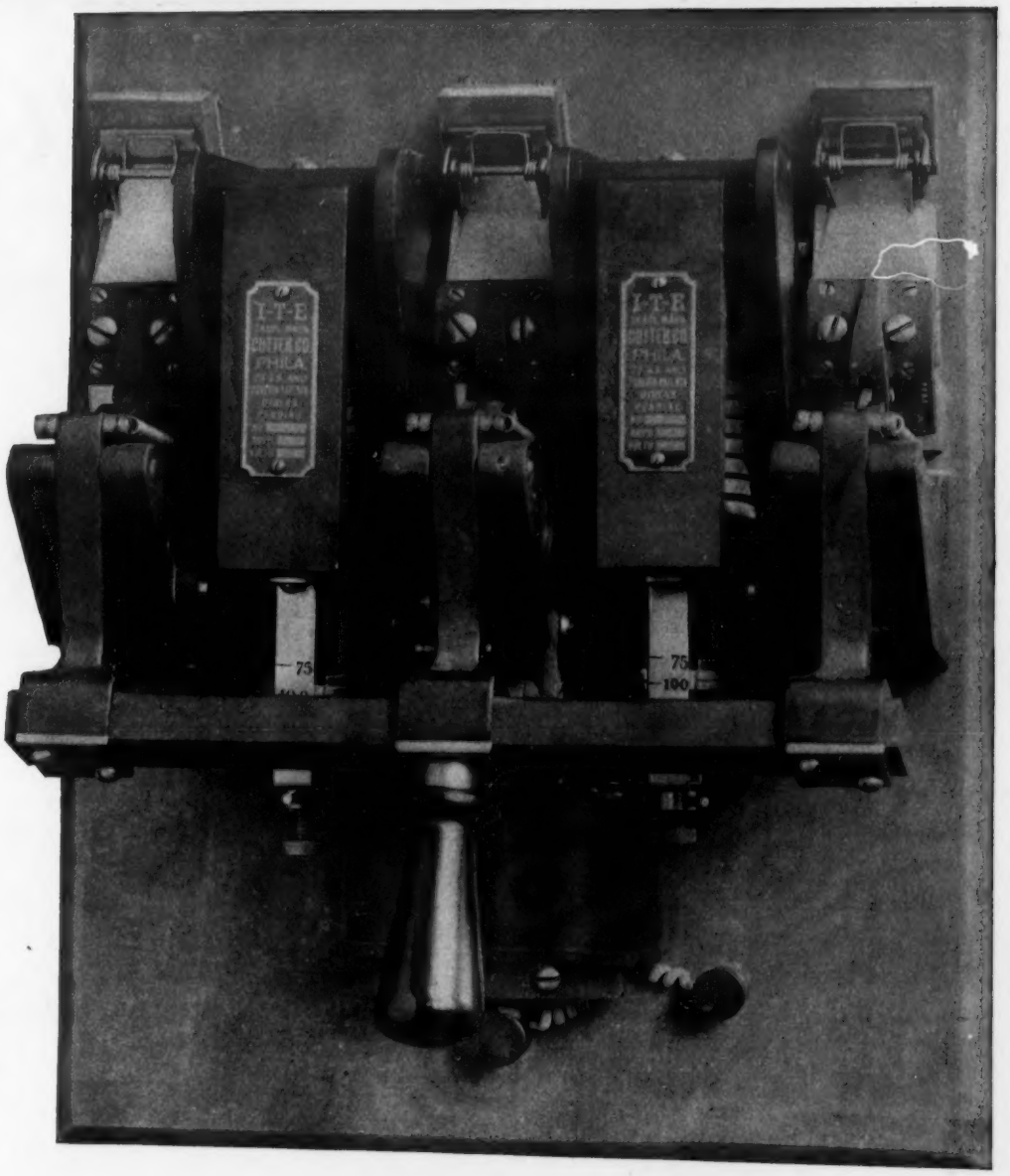

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For Two- and Three-Phase Alternating Current Service

We brought out this Circuit Breaker some years ago to meet the need for a protective device for polyphase motors. Some of the manufacturers of this class of apparatus ridiculed the idea of the need of circuit breakers for their motors; said they were built to stand overloads and would not be injured by them. Perhaps they were mistaken, or possibly they forgot that it is necessary to protect the motor-driven machinery as well as the motor itself. However that may be, a constantly growing number of the I-T-E "Overload and No Voltage" Circuit Breakers shown in the illustration are in daily use on alternating current motor circuits.

The "No Voltage" feature is so arranged that an open circuit in any one phase operates the Circuit Breaker, thus insuring that the motor will remain in circuit only during proper running conditions. Many a polyphase motor has been burnt out as the result of the disconnection of one phase, as may result from the blowing of a fuse; many a generating plant has been seriously overloaded at starting up, because the motors were already in circuit. The I-T-E "Overload and No Voltage" Circuit Breaker offers a reliable and effective remedy. It is the "ounce of prevention" that is worth many pounds of cure.

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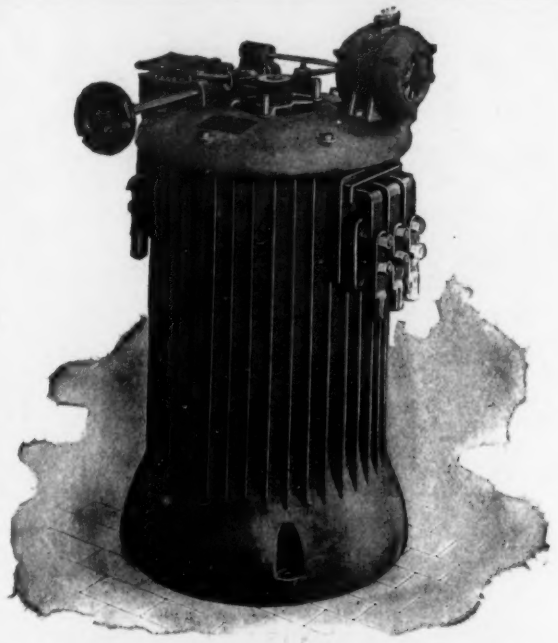

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No risk to you if you buy.

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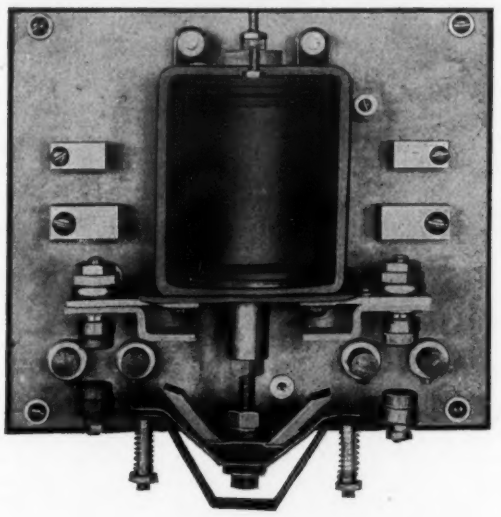
Milwaukee

C & H Solenoid Controlled Switches



These switches are designed for use where the current is frequently made and broken, and also for where it is desired to handle large amounts of energy from a distance without the use of expensive leads.

To actuate them requires but from one-quarter to one ampere, which allows the use of inexpensive wire. The current carrying parts are easily and cheaply renewable, and are made up in the press wherever possible to insure positive interchangeability.

These switches are furnished with or without blowout magnets as desired. Bulletin 74 gives full description and prices.

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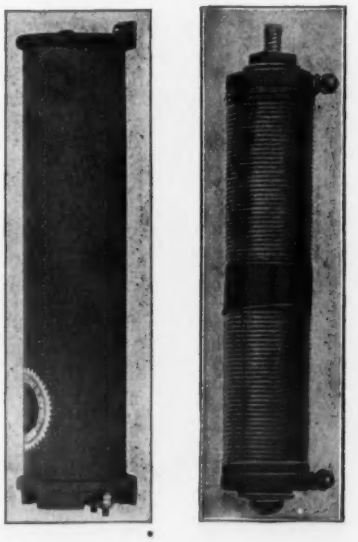
"Carpenter Type"

These units are accurately and carefully made, the resistance wire being wound on a heavy porcelain base.

Ample margin of safety for overload is provided, they have low temperature rise, and have no temperature change in resistance. Made in a variety of sizes with ohms and amperes stamped on the terminal band of each unit.

Bulletin 93 gives detailed information and prices.



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THE SECOND ISSUE OF EACH MONTH

WILL BE THE REGULAR

Export Number of the ELECTRICAL WORLD

conducted along the lines which have proven so successful in the case of the export numbers of the Electrical World and Engineer.

These issues have been instrumental in bringing the electrical manufacturers in this country to the attention of the users of electrical apparatus in foreign countries to a much larger extent than was even anticipated when they were instituted by the Electrical World and Engineer. Manufacturers who have used their pages extensively have told us that they have received numerous inquiries from practically every foreign country and that considerable business has resulted therefrom. Everyone who has systematically taken advantage of these opportunities has reported his gratification with the results.

Our London office is in close touch with the conditions in Europe and our foreign correspondents keep us posted with regard to conditions all over the world.

The manager of the export department of one of the largest electrical manufacturing companies in this country recently stated after giving the matter careful consideration: "The outlook for foreign trade has never been brighter in this country than at present. The superiority of American machinery as compared with European manufacture is being demonstrated every day, and in those markets where the Germans and English have heretofore enjoyed a monopoly, America is now gradually obtaining the lion's share of the business."

The export issues are compiled with the intention of interesting the possible purchasers of American apparatus in foreign countries.

Owing to the consolidation of the Electrical World and Engineer and the American Electrician, resulting in the first issue of the month being the big number having the circulation of the two papers combined, it has become necessary to change the export issue to the second issue of the month, which fact we would be pleased to have you bear in mind. The first export number of 1906 will be dated January 13th, cuts and copy for which should be in our possession not later than January 6th.

ELECTRICAL WORLD

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MAY BE MOUNTED IN ANY POSITION

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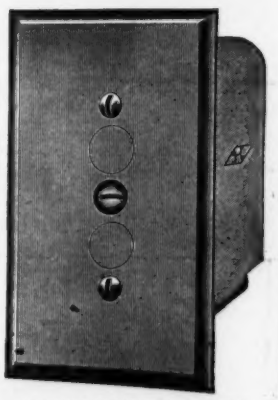

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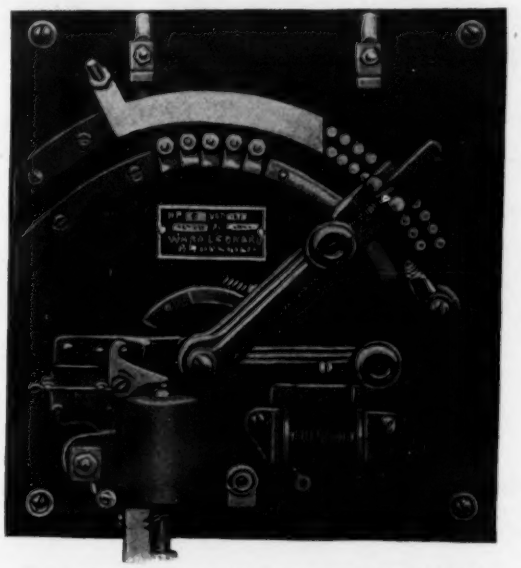
Independent, Interlocking, "Overload" Circuit Breaker and "No-voltage" Release



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A perfect machine tool controller equipped with "no-voltage" release and an independent interlocking "overload" circuit breaker protecting the motor and the entire circuit from abnormal electrical stresses and guarding the motor driven machine from undue mechanical strains.

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Buy Ward Leonard experience it will save you money.

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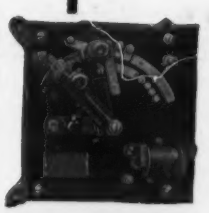

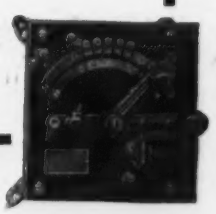

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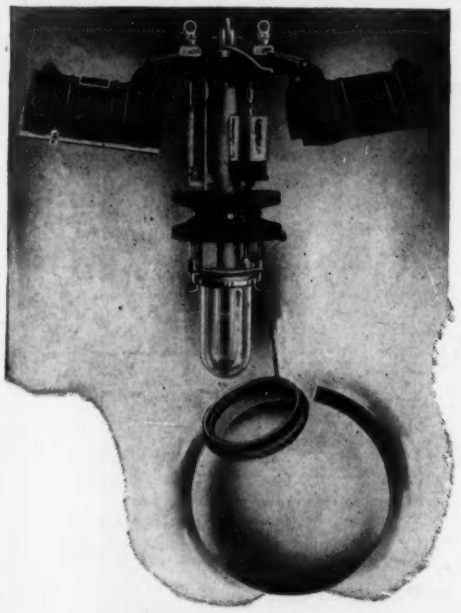

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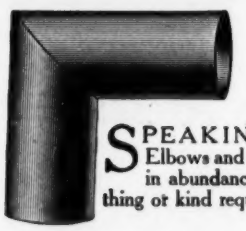

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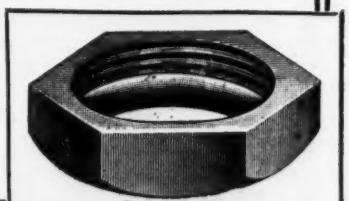

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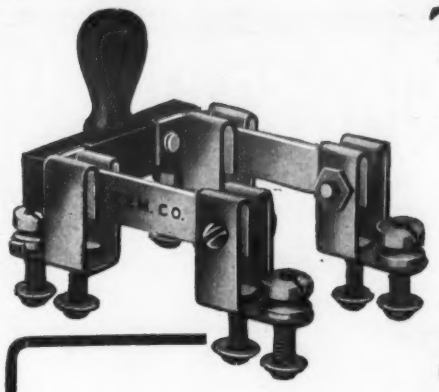
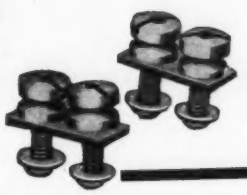


Trumbull Panel Switch



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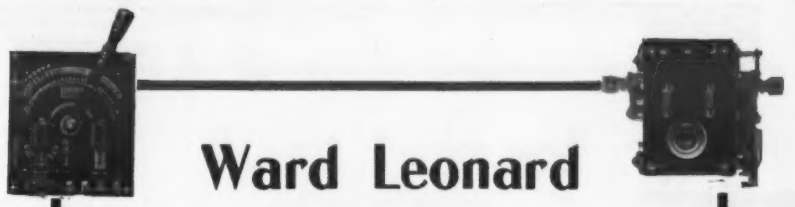

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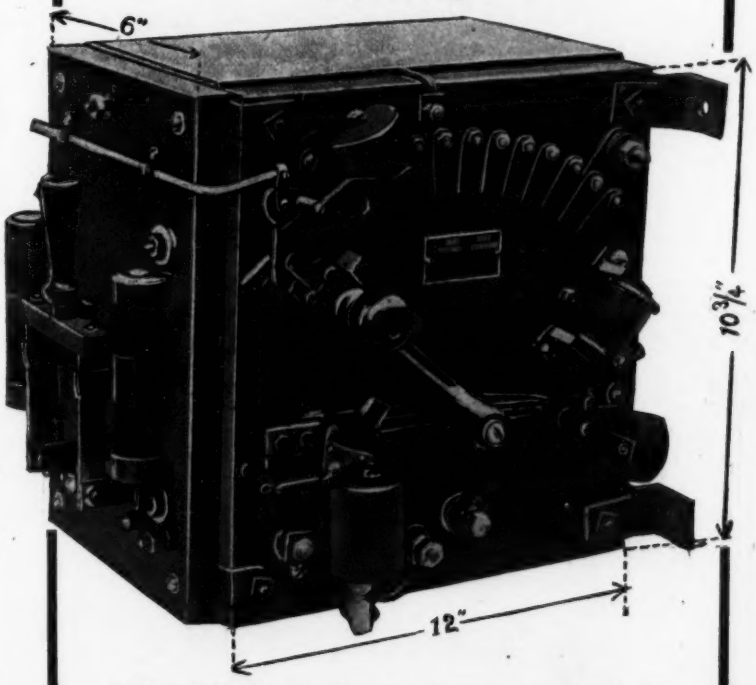

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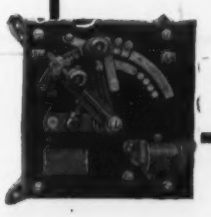

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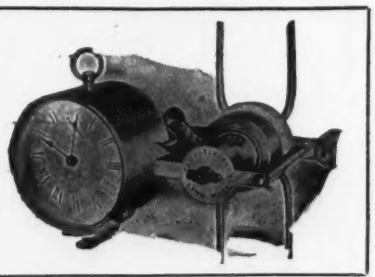

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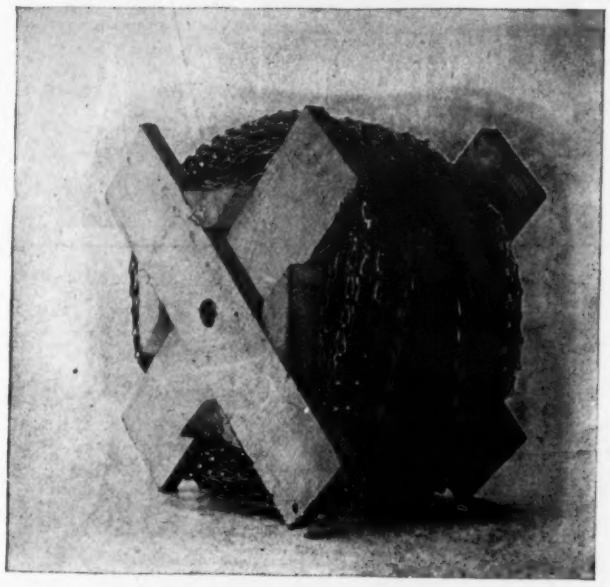

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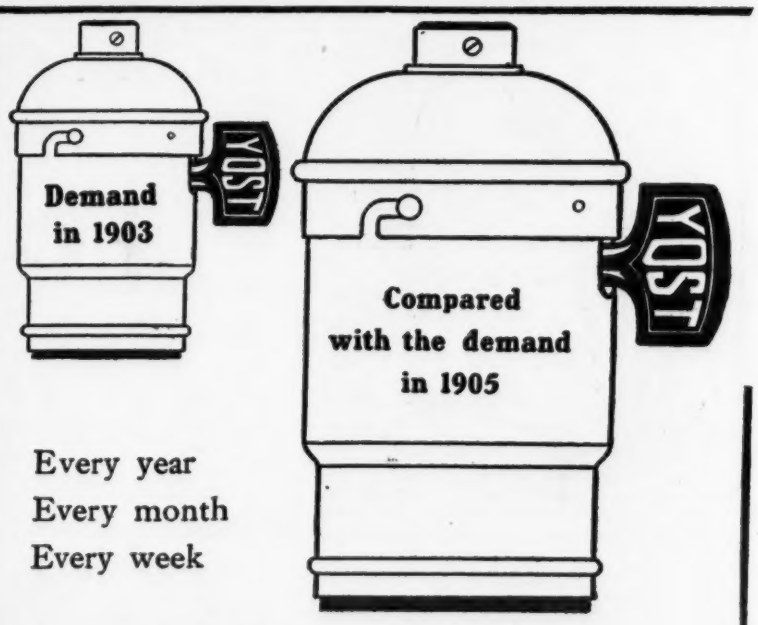

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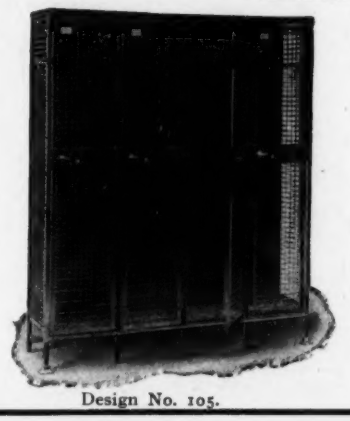

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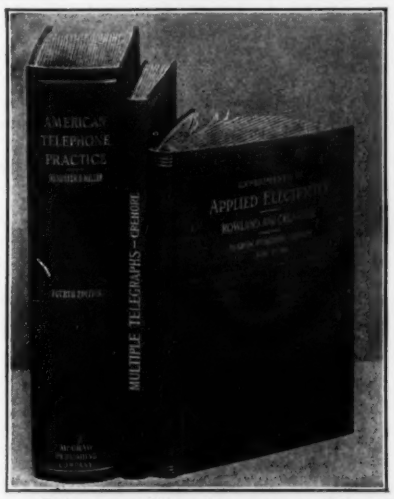

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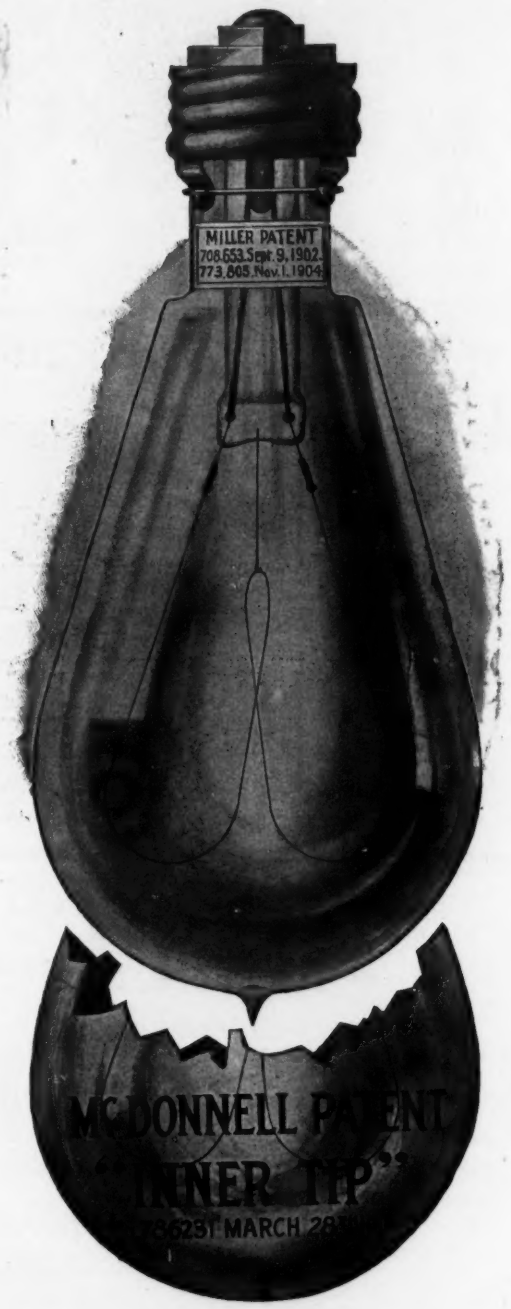

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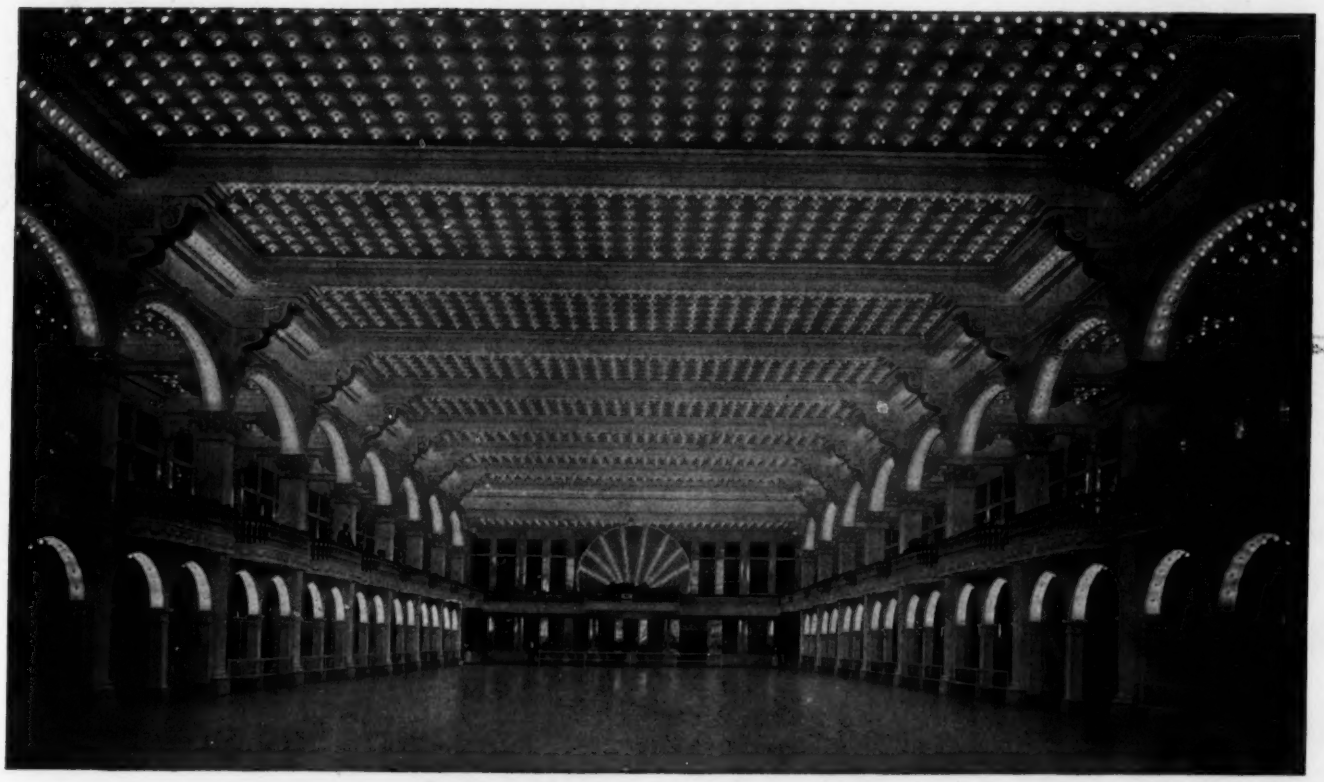

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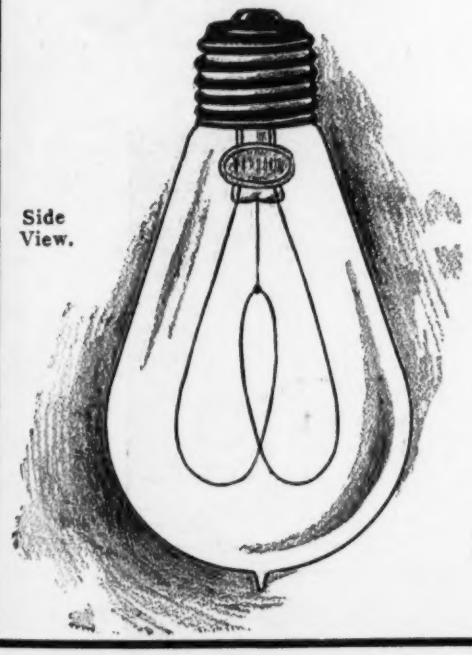

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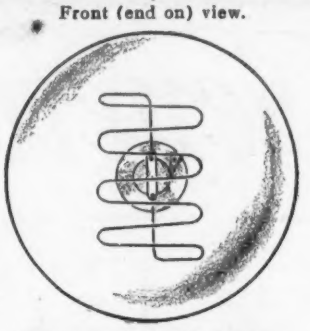
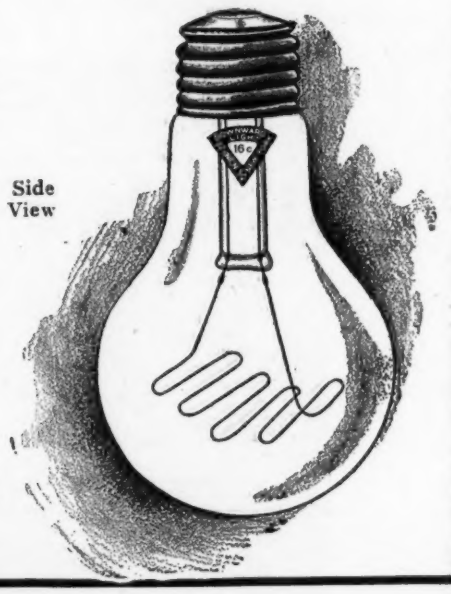


Downward Light Lamp.

Side View



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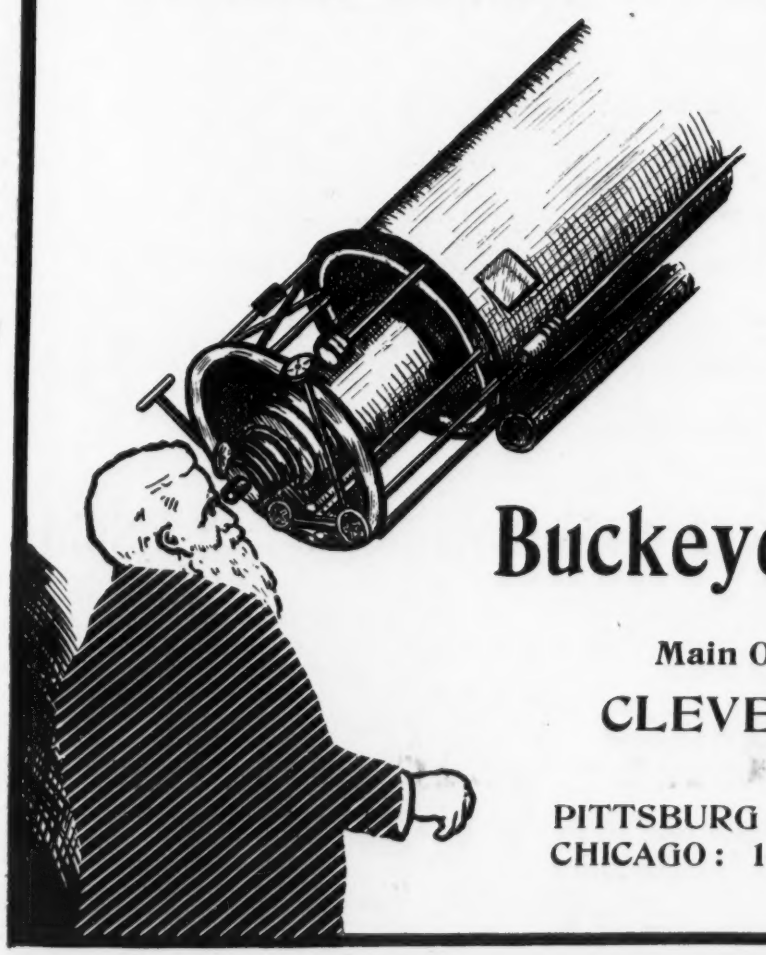

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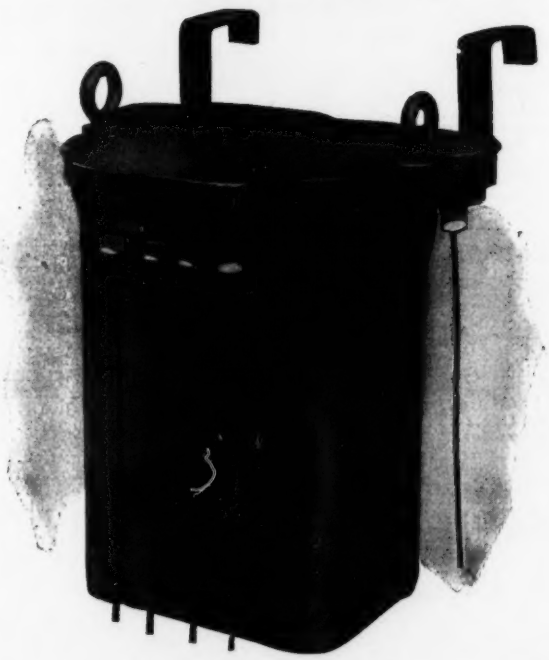

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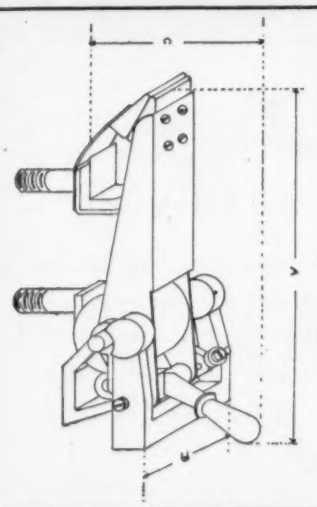

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15	7	2½	3¾
35	7	2½	3¾
50	8½	3	4½
75	8½	3	4½
100	8½	3	4½
150	10	4	5½
200	10	4	5½
300	10	4	5½
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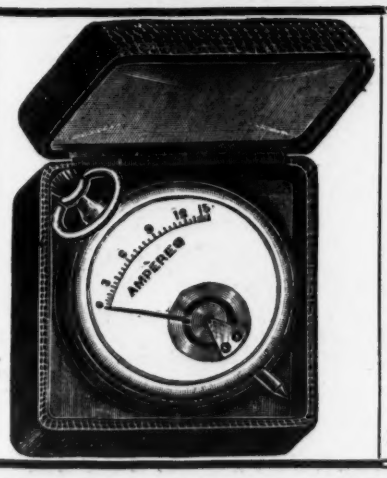

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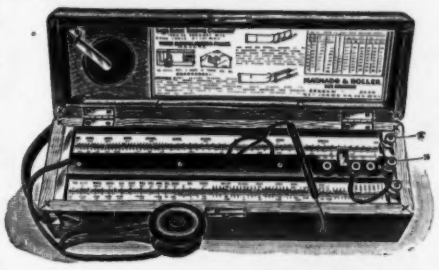

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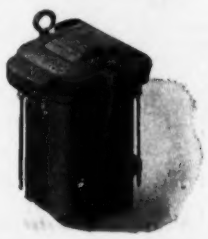

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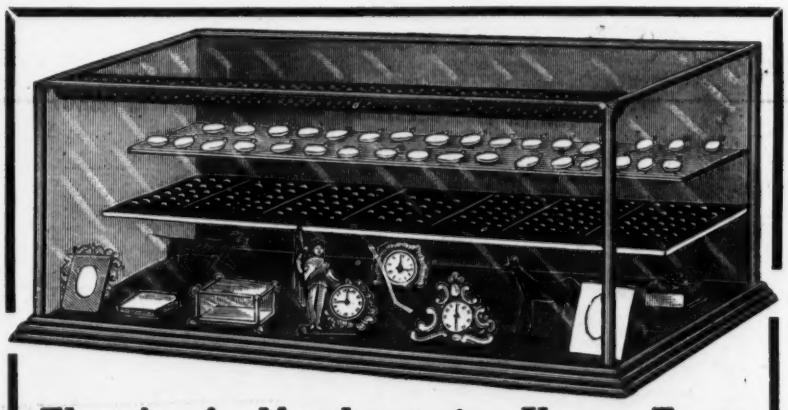

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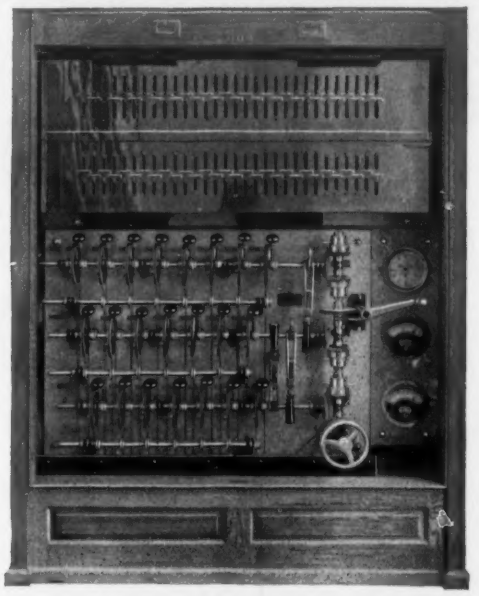

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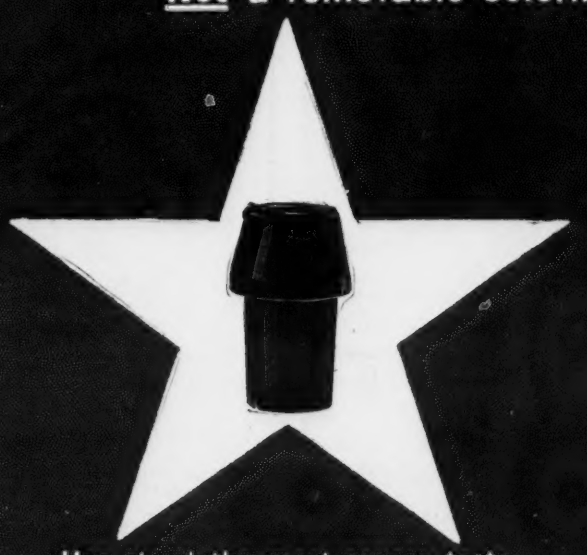

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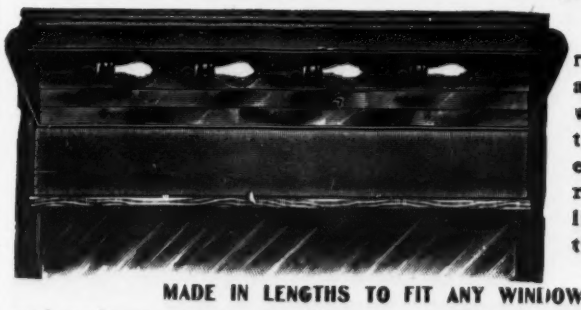

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Aiton Machine Co.
American Insulating Mach. Co.
New England Butt Co.

INSULATING MATERIAL, CHINA AND PORCELAIN.
Empire China Works.
Hartford Faience Co.
Imperial Porcelain Works.
Lima Insulator Co.
Locke Insulator Mfg. Co.
Pass & Seymour, Inc.
Sears, Henry D.
Star Porcelain Works.
Sun Porcelain Co.

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Macon-Evans Varnish Co.
Standard Paint Co.
Standard Underground Cable Co.
Standard Varnish Works.
Sterling Varnish Co.

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Johns-Manville Co., H. W.
Mica Insulator Co.
Munsell & Co., Eugene.
Standard Underground Cable Co.

INSULATING MATERIAL, FIBRE.
American Vulcanized Fibre Co.
Delaware Hard Fibre Co.
Diamond State Fibre Co.
Kartavert Mfg. Co.
Morris Electric Co.
Vulcanized Fibre Co.

INSULATING MATERIAL, LAVA.
American Lava Co.
Kruesi, P. J.
Steward Mfg. Co., D. M.

INSULATING MATERIAL, MICA.
Johns-Manville Co., H. W.
Mica Insulator Co.
Munsell & Co., Eugene.
Vance, D. T.

INSULATING MATERIAL, SILK.
Ryle & Co., Wm.

INSULATING MATERIAL, STAPLES.
Blake Signal & Mfg. Co.

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Electric Appliance Co.
Mica Insulator Co.
Morgan & Wright.
New York Insulated Wire Co.
Okonite Co., Ltd.
Standard Underground Cable Co.

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Empire China Works.
Imperial Porcelain Wks.
Johns Manville Co., H. W.
Lima Insulator Co.
Locke Insulator Mfg. Co.
Pass & Seymour, Inc.
Sears, Henry D.
Star Porcelain Works.
Sun Porcelain Co.

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Lima Insulator Co.
Locke Insulator Mfg. Co.

JACKS.
North Penn Iron Co.
Watson-Stillman Co.

JEWELS.
Whitlock & Co., O. S.

LAMP ADJUSTERS.
Incan. Electric Lt. Manip. Co.

LAMP-MAKING MACHINERY.
Dwyer Machine Co.

LAMPS, ARC.
Adams-Bagnall Elec. Co.
Allgemeine Elektricitäts Gesellschaft.
American Arc Lamp Co.
American Electrical Supply Co.
Anderson Mfg. Co., A. & J. M.
Bissell & Co., F.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Doubleday-Hill Elec. Co.
Fort Wayne Electric Works.
General Electric Co.
Stanley G. I. Elec. Mfg. Co.
Toerring Co., C. J.
Wesco Supply Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

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Incan. Electric Lt. Manip. Co.

LAMP HOLDERS.
Crescent Co.

LAMPS, INCANDESCENT.
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Brilliant Electric Co.
British Thomson-Houston Co.
Brush Elec'l Engineering Co.
Buckeye Electric Co.
Central Electric Co.
Columbia Inc. Lamp Co.
Downward Light Electric Co.
Dwyer Machine Co.
Edison Dec. & Min. Lamp Co.
General Electric Co.
Missouri American Elec. Co.
New York & Ohio Co.
Phelps Co.
Sawyer-Man Electric Co.
Warren Elec. & Specialty Co.
Wesco Supply Co.
Western Electric Co.
Westinghouse Elec. & Mfg. Co.

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Jaeger Min. Lamp Co.

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Phelps Company.

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Garvin Mch. Co.
Niles-Bement-Pond Co.
Sebastian Lathe Co.

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Garton-Daniels Co.
Lord Electric Co.
Stanley-G. I. Elec. Mfg. Co.
Westinghouse Elec. Mfg. Co.

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Merritt & Co.

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LUBRICATORS.
Lunkenheimer Co.

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Long & Allstatter Co.
Newton Mch. Tool Works.
Niles-Bement-Pond Co.
Pratt & Whitney Co.
Sebastian Lathe Co.
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Williams Elec. Mfg. Co.

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Kilbourne & Clark Co.

MAST ARMS.
Brady, T. H.

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Sturtevant Co., B. F.

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Splitdorf, C. F.

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Baker & Co., Inc.
Croselmire & Ackor.
Hungerford Brass & Copper Co., U. T.
Phosphor Bronze Smelting Co.

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Hoffman, George W.

METAL STAMPING.
Hills Co., Geo. Q.

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Parsell & Weed.

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Elm City Engineering Co.

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Cincinnati Tool Co.
Utica Drop Forge & Tool Co.

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Cornwell Co., R. M.

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Bates Machine Co.

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National Acme Mfg. Co.

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Lunkenheimer Co.

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Kellogg & Co., E. H.

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Burt Mfg. Co.

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Peerless Rubber Mfg. Co.

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Rosenbaum & Stockbridge.
Townsend & Decker.
Woodworth, George H.

PHOTOMETERS.
Dwyer Machine Co.
Electric Motor & Equipment Co.

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PHOTOMETER STANDARDS.
Electrical Testing Laboratories.

PHOSPHOR BRONZE.
Phosphor Bronze Smelting Co.

PINIONS, RAWHIDE.
New Process Rawhide Co.

PINS, STEEL.
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Mott Iron Wks., J. L.

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Brady, T. H.
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Sand Point Cedar Co.
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Sterling & Son, W. C.
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Jeffrey Mfg. Co.
Link-Belt Engineering Co.
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Niles-Bement-Pond Co.
Xylotite Product Co.

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Niles-Bement-Pond Co.
Watson-Stillman Co.

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Jeffrey Mfg. Co.
Niles-Bement-Pond Co.
Smith Co., S. Morgan.
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Conover Condenser Co.
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Emerson Elec. Mfg. Co.
Platt Iron Works Co.
Quimby, Wm. E.
Watson Machine Co.
Worthington, Henry R.

PUMPS, OIL.
Lunkenheimer Co.

PUMPS, STEAM.
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McGowan Co., J. H.
Morris Company, I. P.
Platt Iron Works Co.
Quimby, Wm. E.
Worthington, Henry R.

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Hubbard's Sons, Norman.
Platt Iron Works Co.
Pulsometer Engineering Co.

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Carlisle & Finch Co.

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Electro-Dynamic Co.
Freeman Elec. Co., E. H.
Paiste Co., H. T.
Sun Porcelain Co.

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American Reflector & Lighting Co.
Frink, I. P.
Gillinder & Sons, Inc.
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Klemm & Co.
National X Ray Reflector Co.
Phoenix Glass Co.
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Vilter Mfg. Co.

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Gregory Electric Co.
Heck, Louis.
Waterbury & Co.

RESISTANCE UNITS.
Electric Controller & Supply Co.

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Simplex Electric Heating Co.
Ward Leonard Electric Co.

RHEOSTATS.
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Globe Elec. Controller Co.
Sundh Electric Co.
Ward Leonard Electric Co.
Wirt Electric Co.

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Sears, Henry D.
Sun Porcelain Co.
Yost Elec. Mfg. Co.

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Aiton Machine Co.

SAL AMMONIAC.
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Roessler & Hasslacher Chem. Co.

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International Correspondence Schools.
Michigan College of Mines.

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National-Acme Mfg. Co.

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Rushmore Dynamo Works.

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Gas & Electric Development Co.
Gregory Electric Co.
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Richter, Eugene.
Rossiter, MacGovern & Co.
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Yearsley & Levene.

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Mobile Electric Co.
Reynolds Electric Flasher Mfg. Co.

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Haller Machine Co.
Mobile Electric Co.

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Pass & Seymour, Inc.
Sarco Co.
Sears, H. D.
Yost Electric Mfg. Co.

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Belden Mfg. Co.

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Crescent Company.
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Brown & Co., L. P.
Simplex Electric Heating Co.

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Underhill, Charles R.

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Warner Instrument Co.

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Cary Spring Works.
Dunbar Bros.
Manross, F. N.

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(See Insulating Material, Staples.)

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Sturtevant Co., B. F.

STEEL.
American Bridge Co.
Hungerford Brass & Copper Co., U. T.
North Penn Iron Co.

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Westinghouse, Church, Kerr & Co.

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Standard Electrical Works.
Westinghouse Elec. & Mfg. Co.

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Doubleday-Hill Elec. Co.
Electric Appliance Co.
Electrical Equip. & Supply Co.
General Electric Co.
Kilbourne & Clark Co.
Manhattan Elec'l Supply Co.
Ostrander & Co., W. R.
Standard Electrical Works.
Stuart-Howland Co.
Wesco Supply Co.
Western Electric Co.
Westinghouse Elec. & Mfg. Co.

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Rogers Telephone & Elec. Co.
Sterling Electric Co.
Western Electric Co.

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Bullock Electric Mfg. Co.
Crescent Elec'l Mfg. Co.
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Electro-Dynamic Co.
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Kellogg Switchboard & Supply Co.
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Wagner Elec. Mfg. Co.
Waterbury & Co.
Wesco Supply Co.
Worcester Electric Mfg. Co.

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Sorenson, P.

SWITCHES, CLOCK.
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Campbell Elec. Co.
Crescent Company.
Electric Motor & Equipment Co.
Hartford Time Switch Co.
Kilbourne & Clark Co.

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Bissell Co., F.
Bossert Elec. Const. Co.
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General Electric Company.
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La Roche Co., F. A.
Sterling Electric Co.
Trumbull Elec. Mfg. Co.
Waterbury & Co.
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High Tension Elect. Spec. Co.

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Sorenson, P.
Trumbull Elec. Mfg. Co.

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Crescent Elec'l Mfg. Co.
La Roche Co., F. A.
Trumbull Elec. Mfg. Co.

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Schaeffer & Budenberg.

TAPE. (See Insulating Material, Tape.)

TAPS AND DIES.
Carpenter Tap & Die Co., J. M.
Pratt & Whitney Co.

TELEPHONES.
American Bell Telephone Co.
American Electric Telephone Co.
Atwater-Kent Mfg. Co.
Automatic Elec. Co.
Bissell Co., F.
Holtzer-Cabot Elec. Co.
International Tele. Mfg. Co.
Kellogg Switchboard & Supply Co.
Manhattan Elec'l Supply Co.
Rogers Telephone & Elec. Co.
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Stromberg-Carlson Tele. Mfg. Co.
Viaduct Mfg. Co.
Wesco Supply Co.
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New York Telephone Co.

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United Telpherage Department.

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Electrical Testing Laboratories.

TESTING LABORATORY.
Electrical Testing Laboratories.

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Crawfordsville Electric Co.
Devine, J. P.
Fort Wayne Electric Works.
General Electric Co.
Gregory Electric Co.
Moloney Electric Co.
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Wesco Supply Co.
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United Telpherage Department.

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Kerr Turbine Co.
Morris Co., I. P.
American Turbine Engine Co.
Westinghouse Machine Co.

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Lunkenheimer Co.
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VISES.
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Leffel & Co., James.
Pelton Water Wheel Co.
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Smith Co., S. Morgan.

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Doble Co., Abner.
Lombard Governor Co.
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Sturgess Governor Eng'ring Co.
Woodward Governor Co.

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North Penn Iron Co.
Yale & Towne Mfg. Co.

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New England Butt Co.

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International Telegraph Constr. Co

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Aiton Machinery Co.
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Clark Insulation Co.
Crescent Insulated Wire & Cable Co.
Driver Harris Wire Co.
Eastern Electric Cable & Wire Co.
Electric Appliance Co.
Electrical Equip. & Supply Co.
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Indiana Rubber & Ins. Wire Co.
Moore, A. F.
National Conduit & Cable Co.
National India Rubber Co.
New York Insulated Wire Co.
Okonite Co., The.
Roebling's Sons Co., J. A.
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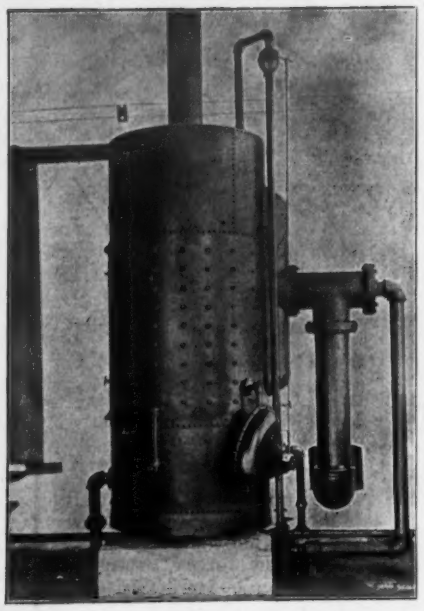

161% per year on a Stilwell Feed-Water Heater

PROBLEM:—A man bought a single-cylinder, automatic engine requiring per hour 3,000 lbs. of steam at 80 lbs. pressure. He put in a water-tube boiler and used Pocahontas coal costing $4.00 per ton and evaporating per lb. of coal 7 lbs. of water from feed water at 210° F. to steam at 80 lbs. pressure. The temperature of the cold feed water was found to average 60° F., and it was also found that a Stilwell feed-water heater, costing $240, would heat it to 210° F., at the same time preventing all scale forming substances from entering and incrusting the boiler. Find the yearly rate of profit on the investment in the heater, assuming that the plant runs 10 hours per day 300 days per year, and neglecting the saving in boiler cleaning and repair bills.

ANSWER:—The total number of British thermal units required to transform water from 60° F. to steam at 80 lbs. is 1,153, of which the Stilwell heater furnishes 210 — 60 = 150. The work done by the heater is therefore 15% of that done by the coal. The amount of steam used during the year is 3,000 × 10 × 300 = 9,000,000. Dividing by 7 we get the lbs. of coal required, or 1,285,714 lbs. = 643 tons. The total cost of the coal is, therefore, 643 × $4.00 = $2,572, and as the Stilwell heater saved an amount equal to 15% of this, it saved $385, which is 161% of $240, the first cost. This is much higher interest than is paid by the insurance companies. Send for our BOOK "EW" on Boiler Feed Water.

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PELTON EFFICIENCY

Instantaneous Photo of Pelton Needle Nozzle Stream Operating under 1923 Ft. Head.

The PELTON bucket design and the PELTON needle jet get a far higher efficiency out of any high duty head of water than the best of the next best wheels. NINETY PER CENT bucket efficiency is common with PELTON wheels simply because the bucket design is modified to meet special conditions as they arise. Note above half-tone photo—no twist, no disturbance of water in jet or bucket. All power possible transferred from water to wheel motion. It would pay you to write us about your water problem, and obtain our book on water power.

THE PELTON WATER WHEEL COMPANY
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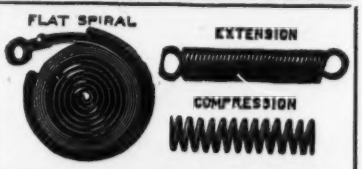

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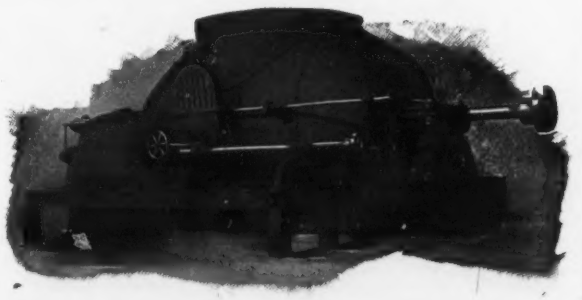

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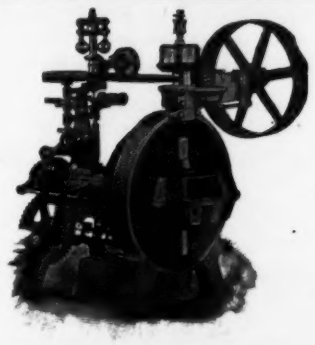

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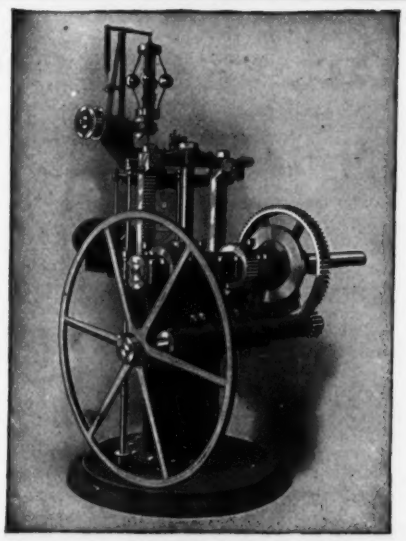

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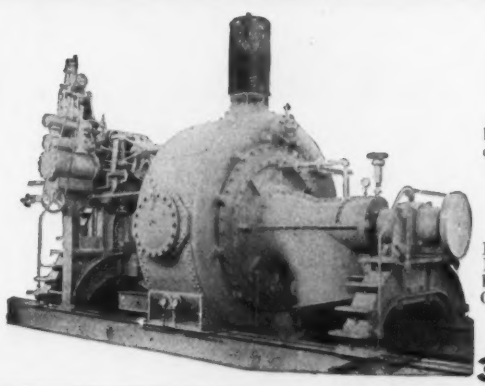

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The illustration shows the large NIAGARA design, HORIZONTAL SHAFT TURBINES recently installed by us for the NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING CO., Niagara Falls, N. Y. Tests conducted by competent engineers developed as follows:

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213 ft.	½	257 r.p.m.	1,750	95%	73.00%
213 ft.	¾	257 r.p.m.	3,000	95%	85.60%
213 ft.	Full	257 r.p.m.	3,500	95%	81.50%

These results have never been equaled by any turbine of the Horizontal Shaft Design, operating under equally HIGH HEADS. The test was made AFTER TURBINES WERE INSTALLED, direct coupled to Generators. Francis's weirs and formulæ for discharge were used. The original test reports on file at our offices. These Turbines are all fitted with our SAMSON BALANCED GATES. Note especially the UNIFORM SPEED at ALL GATEAGES.

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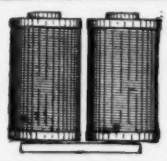

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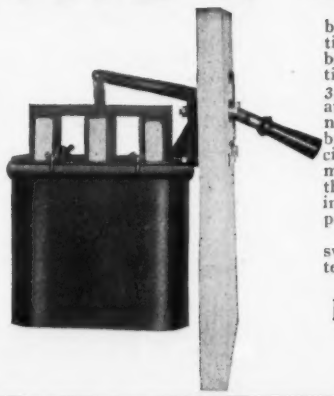

built in two, three and four-pole combinations, single or double throw, for switchboard or wall mounting. Made for capacities up to 200 amp. and for potentials up to 3,300 volts. On account of the low price at which this switch is sold, its use need not be confined to high tension circuits, but it may be installed on low-tension A. C. circuits in connection with large induction motors in mills and factories in place of the usual air-break switch. The wall mounting type can be installed on any convenient post or wall.

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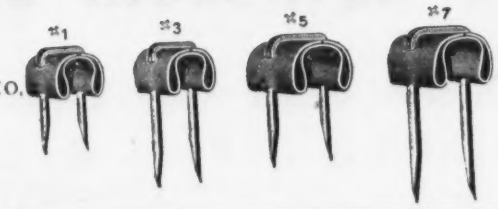

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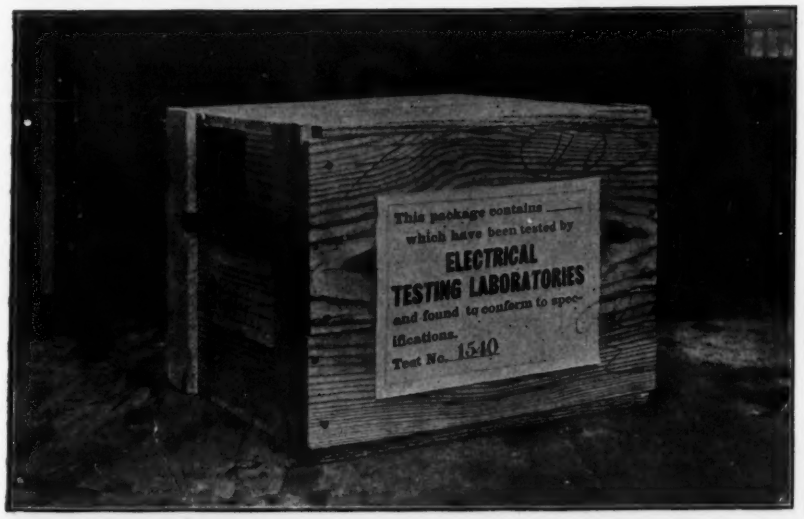

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WANTED.—Manager for an electrical contracting and supply company in a city of 50,000; must be competent to lay out and bid on interior wiring, isolated plants, etc., and be a good buyer. Address No. 3000, care Electrical World and Engineer, New York.

WANTED.—DRAFTSMEN: We have positions now open for draftsmen; call or address Western Electric Company, Chicago, Ill.

A SOUND PROPOSITION always appeals to the sensible man. That our proposition is a sound one, is proven by the fact that we have placed thousands of competent men in desirable positions. If you are dissatisfied with the opportunities offered by your present position, it will be to your advantage to call at our nearest office for information or write for booklet. HAPGOODS, Suite 511, 309 Broadway, New York City.

WANTED.—By an Eastern concern, manufacturers of dynamos and motors, an assistant to their Electrical Designing Engineer; must be familiar and have had previous experience in the designing of dynamos and motors of all types; state salary expected and where last employed. Address No. 2405, care Electrical World and Engineer, New York.

WANTED.—Electrical Draftsmen; pay from $3.04 to $4 per diem. A competitive examination will be held for electrical draftsmen at the Navy Yard, Brooklyn, N. Y., January 4, 1906. For further information, address "Commandant, Navy Yard, Brooklyn, N. Y."

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1	900	Westinghouse 45 K. W., two-phase, 1100 volts.
2	1200	Westinghouse 60 K. W., two-phase, 1100 volts.
2	1500	General Electric 75 K. W., three-phase, 2200 volts.
1	1500	General Electric 75 K. W., three-phase, 3300 volts.
1	1500	Warren-Medberry 75 K. W. two-phase, 1100 or 2200 volts.
3	1500	Westinghouse 75 K. W., single phase, 1100 or 2200 volts.
2	1500	Westinghouse 75 K. W., two-phase, 1100 or 2200 volts.
1	2400	General Electric, 120 K.W., type A. S., single-phase, 1100 volts.
2	3000	Warren, 150 K. W., Inductor.
1	4500	Westinghouse, 225 K. W., two-phase, 1100 or 2200 volts.
1	4500	Westinghouse, 225 K. W., three-phase, 1100 or 2200 volts.

125 TO 133 CYCLES

Lights.		
1	650	T-H. A. 35, 1100 volts.
1	1200	Wstgh., 60 K. W., 1100 v.
1	1200	Gen. Elec., A, 60, 1100 v.
2	1500	Wood, 75 K.W., 1100 or 2200 v.
1	2400	General Electric, 120 K. W., type A. S., 2200 volts.
1	3000	Stanley, inductor type, 150 K. W., two-phase.

250 VOLT GENERATORS

K. W.		
2	12	Westinghouse, M. P., comp.
1	15	Western Elec., M. P., comp.
1	17½	Kester, comp.
1	17½	Eddy, type C, comp.
3	20	Western Elec., M. P., comp.
2	25	Western Elec., M. P., comp.
1	35	Bernard, M. P., comp.
1	45	Am. Eng. Co., M. P., comp.
1	50	C. & C., comp.
1	50	Maine, M. P., comp.
1	55	Fuller, multipolar, comp.
1	75	Westinghouse bipolar with extra armature.
1	75	Westinghouse, M. P.
1	75	Siemens & Halske, Churchward type, M. P., brand new, for direct connection.
1	200	Eddy, multipolar, comp.
1	300	Western Electric, M. P., brand new, 8 pole, 3 bearing.

550 VOLT GENERATORS

K. W.		
1	100	Gen. Elec., M. P., 4 comp.
1	100	Siemens & Halske, M. P., comp.
1	110	General Electric, M. P., 6 pole.
1	200	Thompson Ryan, M. P., comp.

ELECTRIC LOCOMOTIVES

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1	10	Morgan-Gardner, type M, 250 volt, direct current, double motor locomotive, 74 K. W., 42-inch gauge, speed 6 to 10 miles per hour.

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1	10	Towle, M. P., comp.
1	25	Sprague-Lundell, shunt.
1	30	Westinghouse, M. P.
2	60	Browning, new.
2	60	Hobart, M. P.
2	65	Browning, M. P., new.
1	75	Phoenix, comp., direct connected to No. 4 Case engine.
2	75	Westinghouse, M. P.
3	80	Hobart, M. P., new.
2	100	Hobart, M. P., comp.
1	100	Triumph, M. P., comp.
3	110	New England, M. P., comp.
1	110	Akron, M. P., comp.
2	110	Commercial, M. P., comp.
1	120	Commercial, M. P.
1	150	West. Elec., M. P., type N. 1.
1	160	Bernard, self-oiler.
1	170	Western Elec., M. P.
1	270	Gen. Elec., M. P., 15 K.W., d.c. to 8-6 G. E. marine engine.
1	270	Eddy, M. P., comp.
4	340	Western Elec., M. P., comp.
1	350	Edison, 20 K. W.
2	400	Westinghouse, M. P., comp.
1	450	Bullock, M. P., comp.
1	450	Sprague-Lundell, M. P., comp.
1	450	Quaker City, M. P., comp.
1	450	Gen. Elec., M. P., comp.
1	450	West. Elec. M. P., comp.
1	540	Edison, comp., 30 K. W.
1	540	C. & C., M. P., 30 K. W.
3	540	Western Elec., M. P., comp.
1	540	G. E., M. P., comp., 30 K. W.
1	650	Excelsior, M. P., 37½ K. W.
1	650	Milwaukee, M. P., comp.
1	650	Westinghouse, M. P.
2	700	Commercial, M. P., comp.
1	700	Card, M. P., comp.
1	700	Crocker-Wheeler, M. P., comp.
2	800	Gen. Elec., M. P., comp.
1	900	Wagner, M. P., comp.
1	1100	Triumph, M. P., comp.
1	1300	Card, M. P., comp., 75 K. W.
2	1300	West. Elec., M. P., 75 K. W.
2	1350	General Electric, M. P., 75 K. W., 6 pole shunt, direct connected to Ames tandem comp., 11 x 17 x 12 automatic engine.
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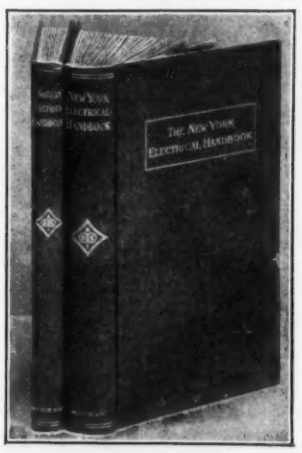

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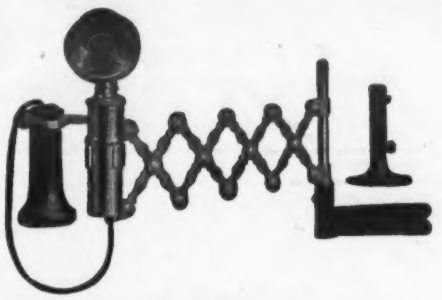

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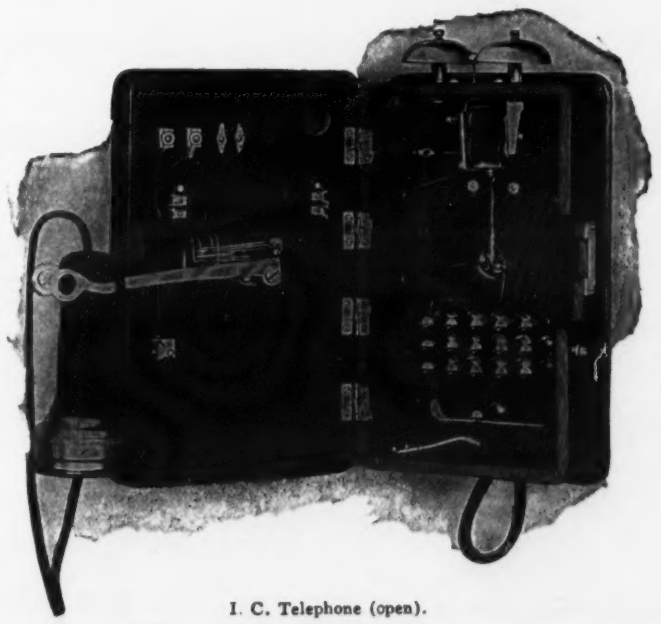
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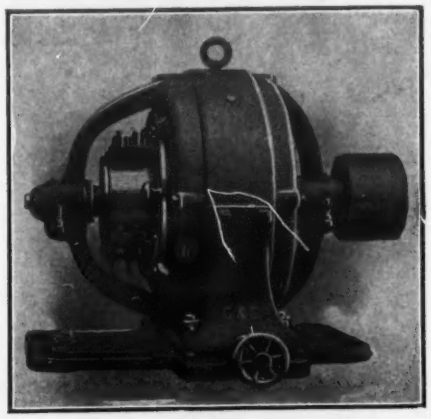

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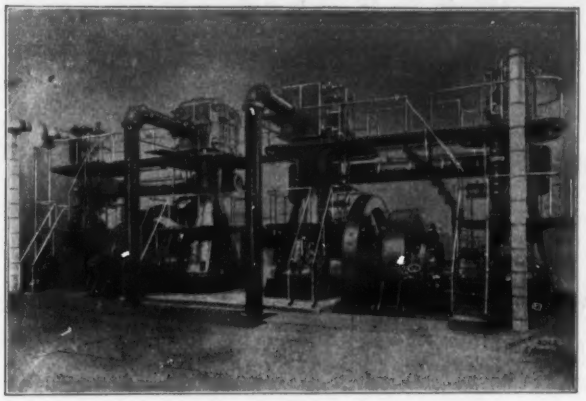

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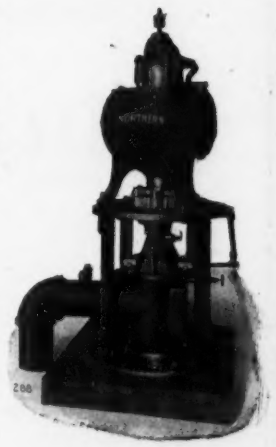

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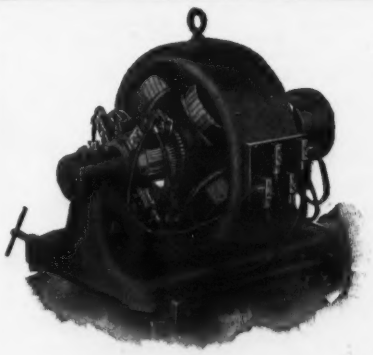

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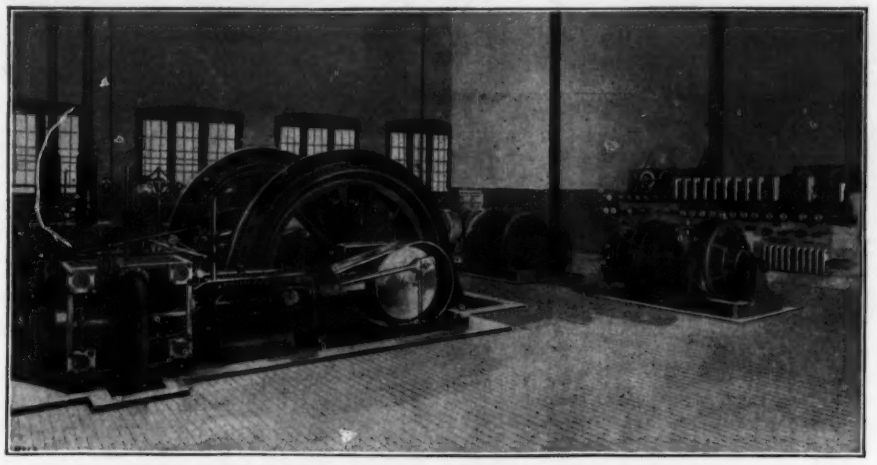

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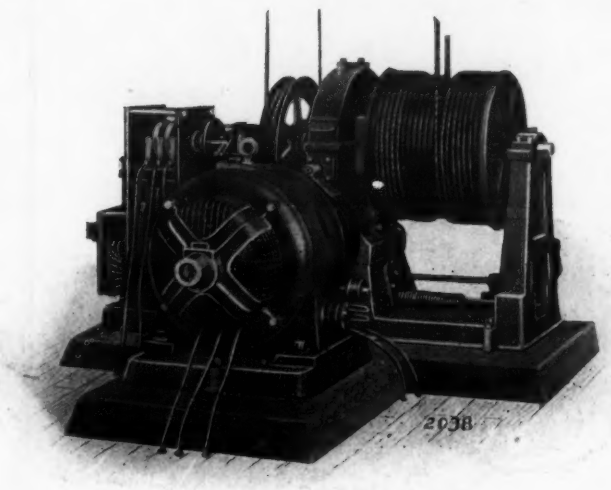

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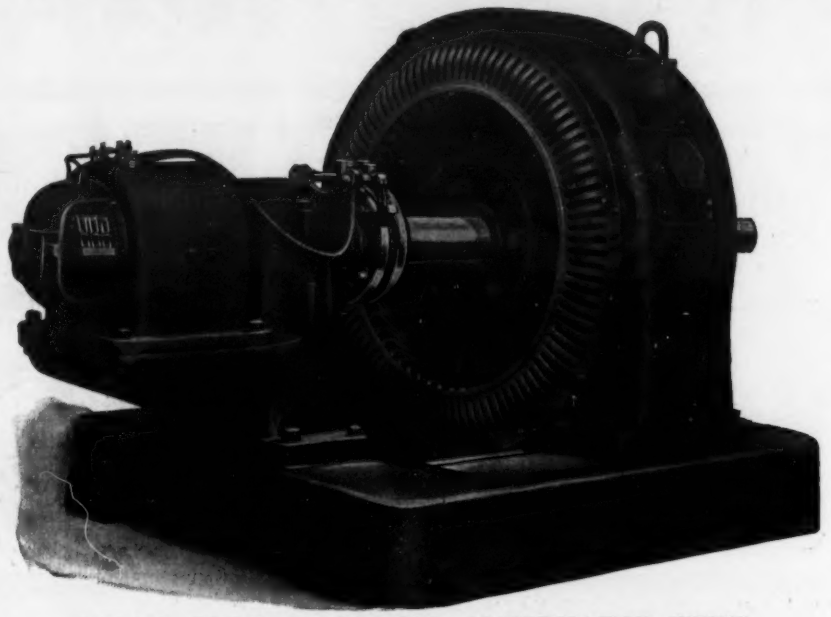

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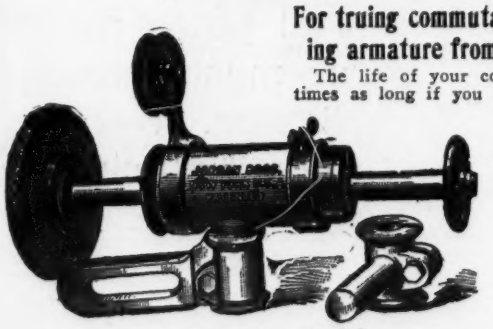

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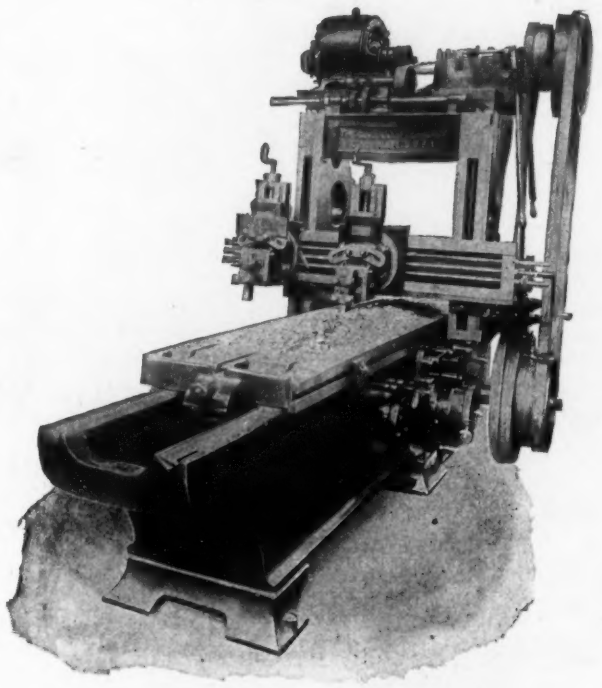

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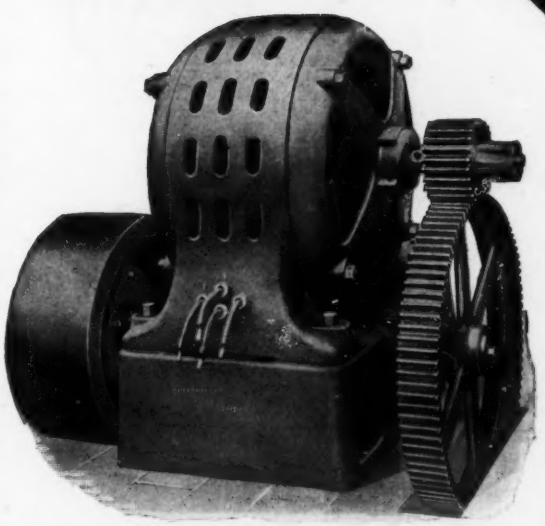

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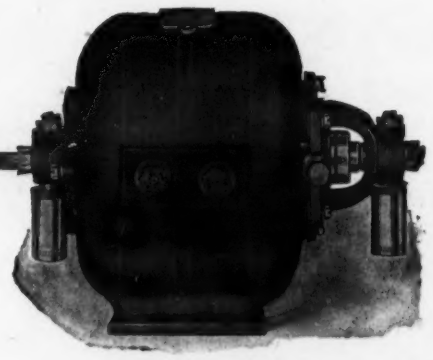

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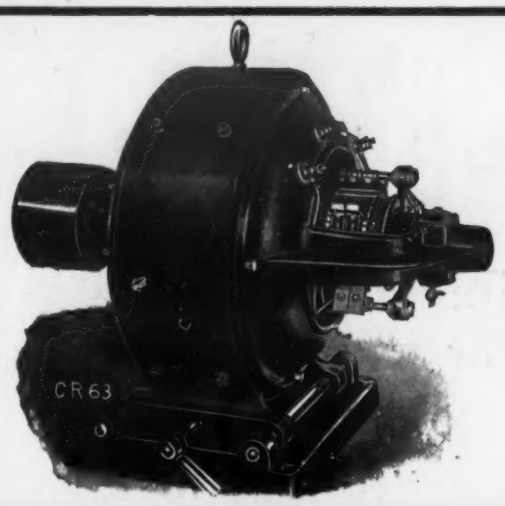

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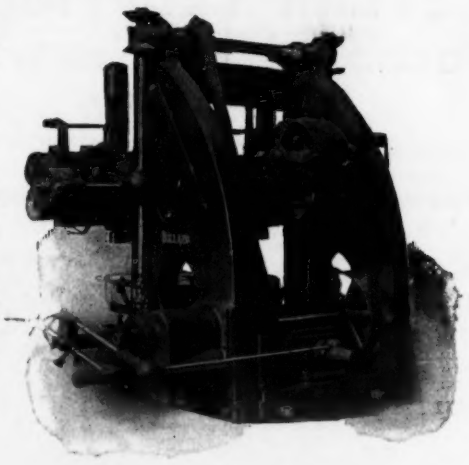

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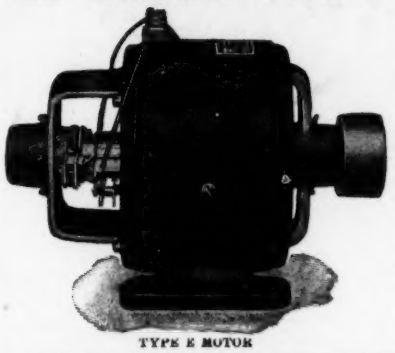

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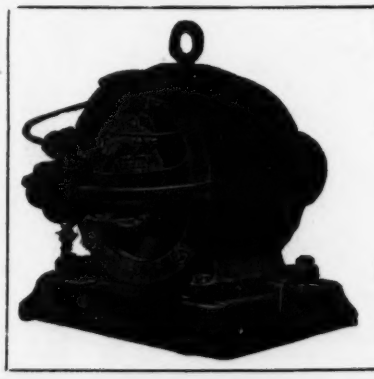

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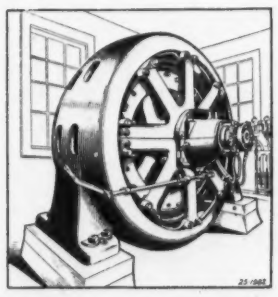

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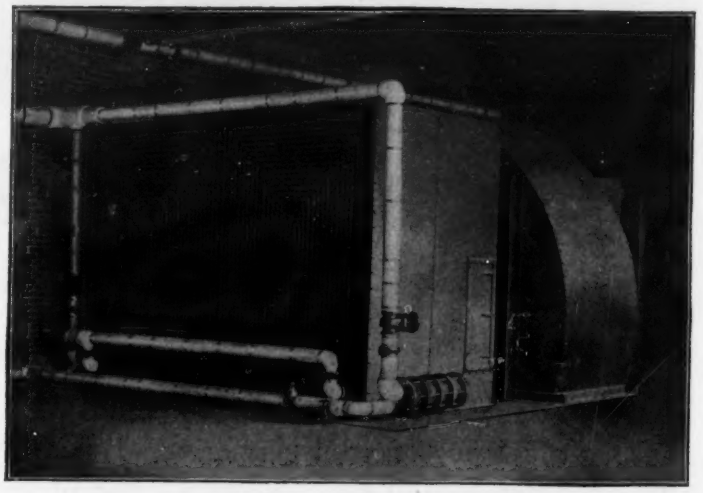

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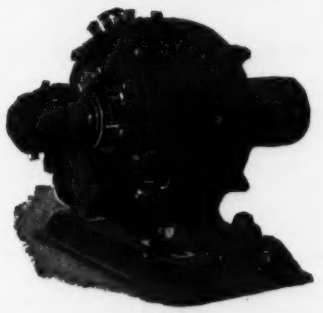

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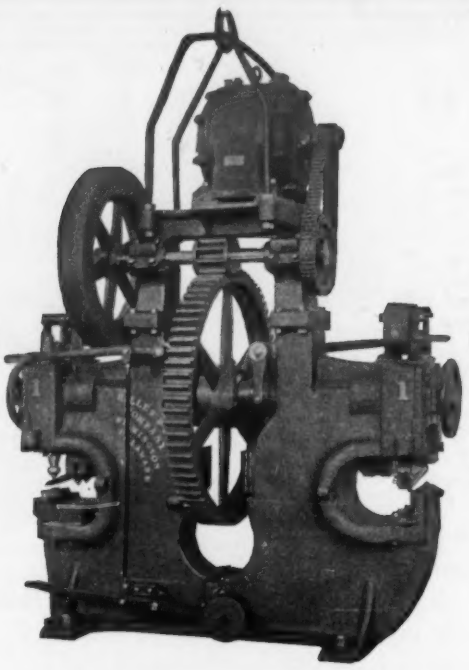

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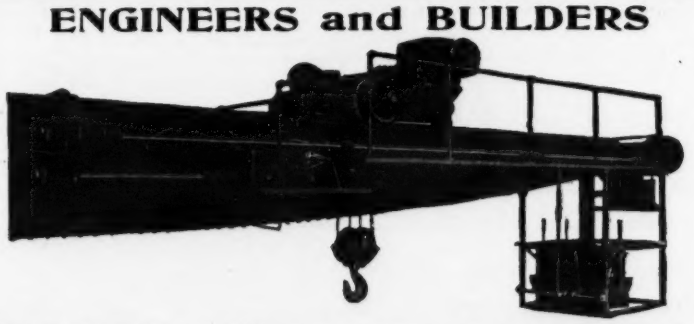

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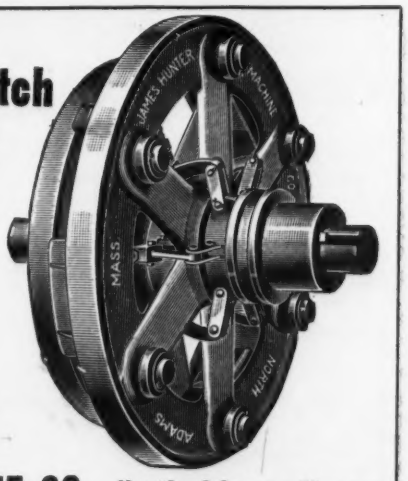

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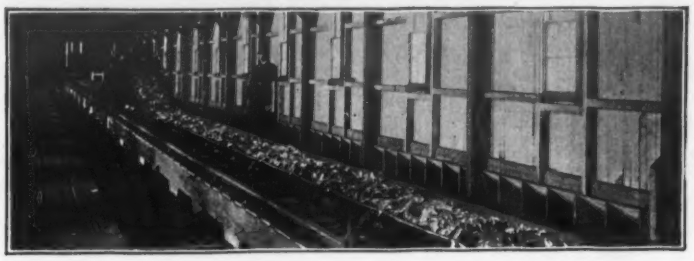

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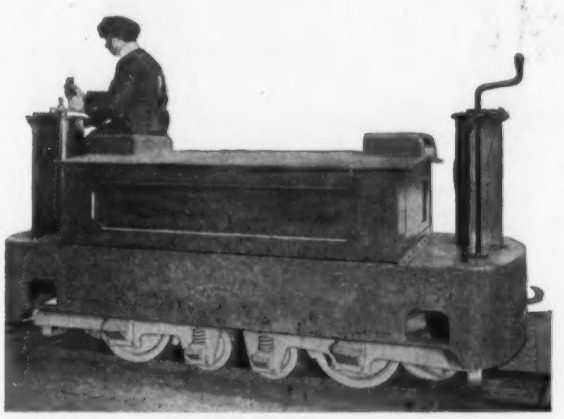

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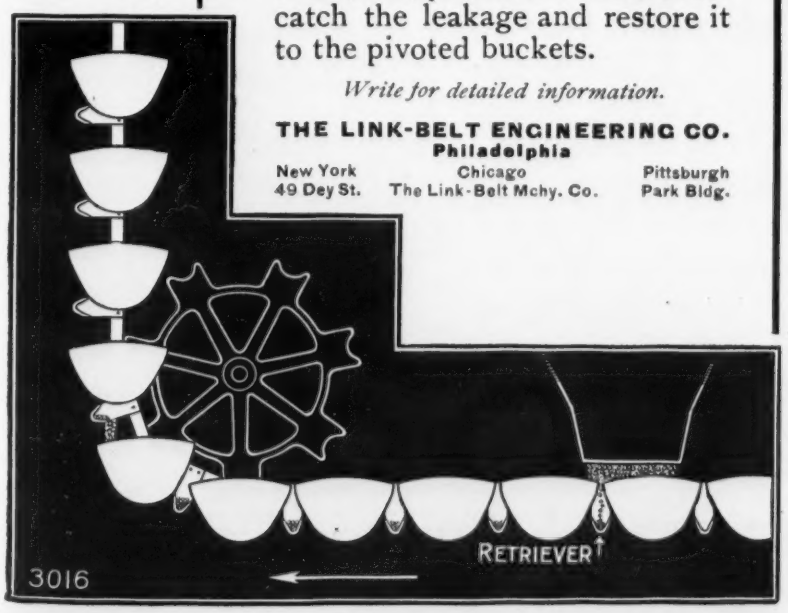

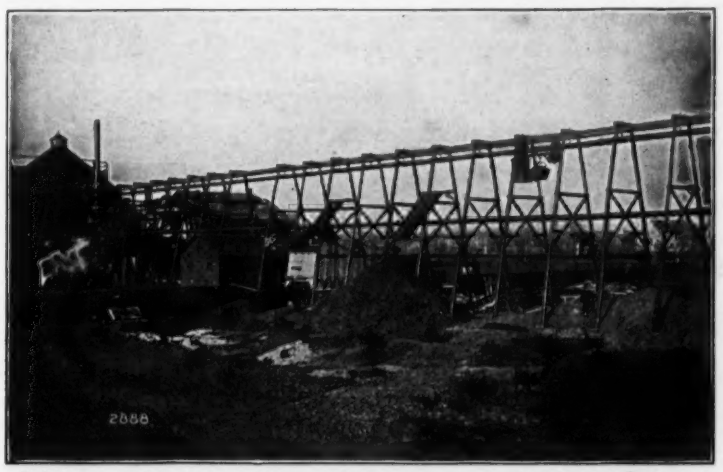

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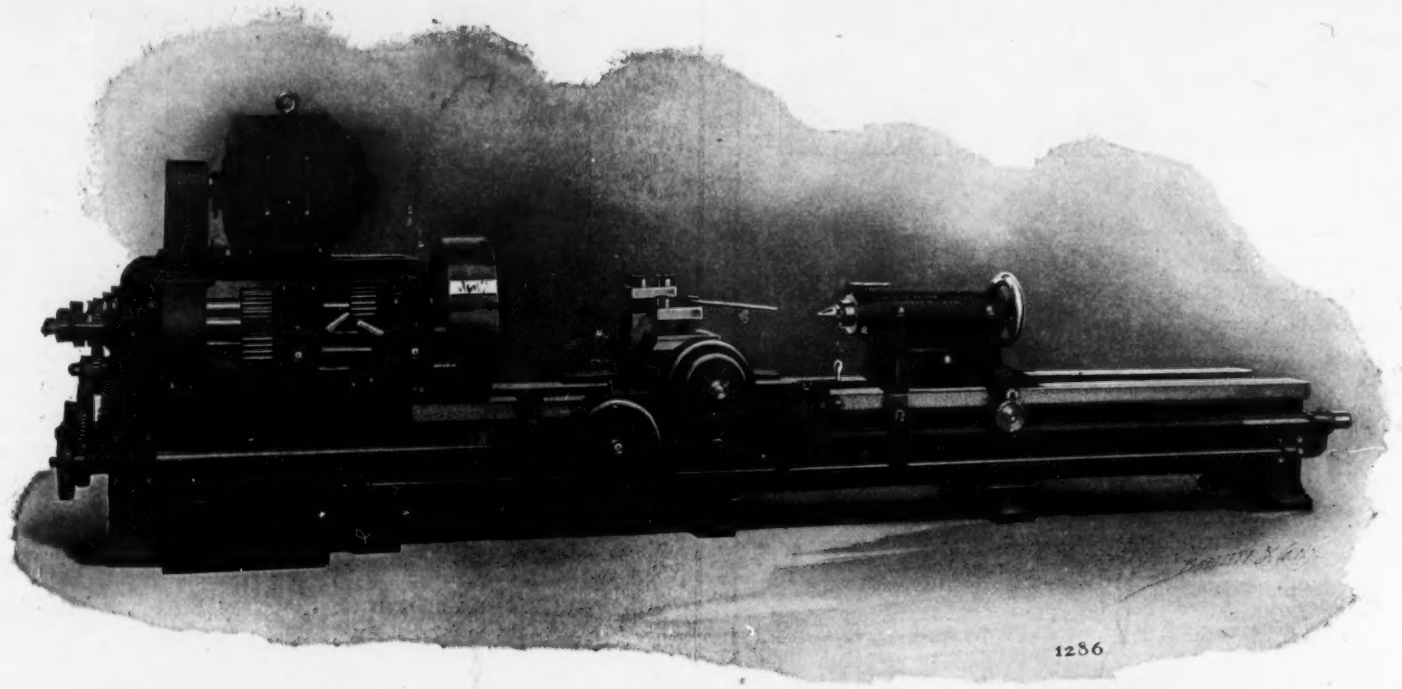

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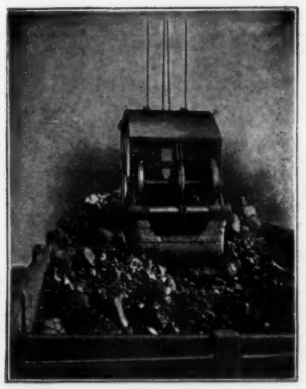

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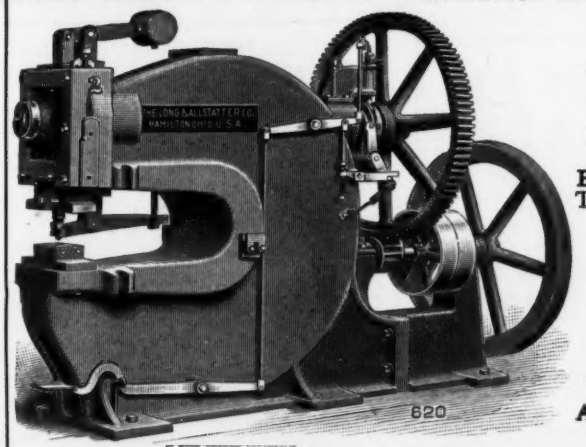

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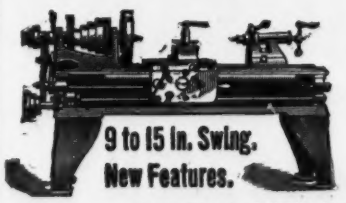

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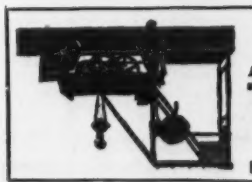

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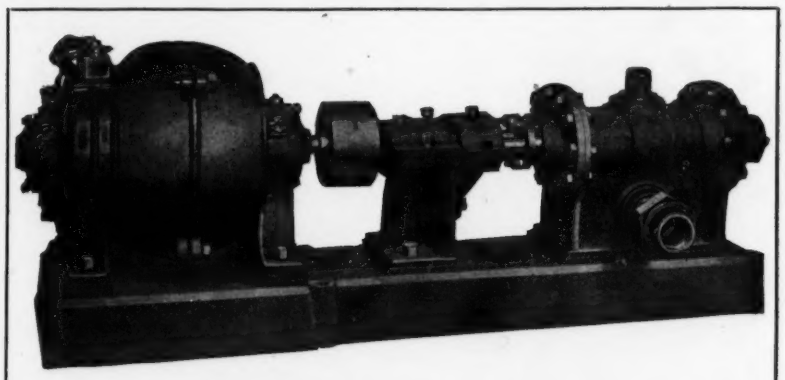

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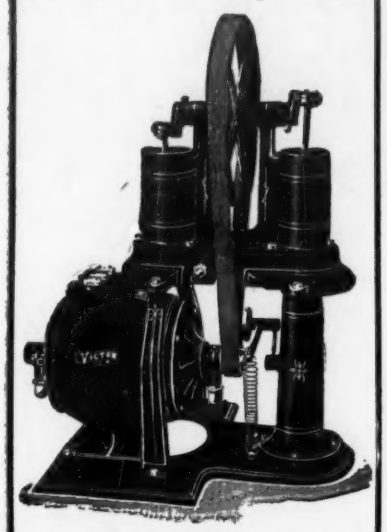

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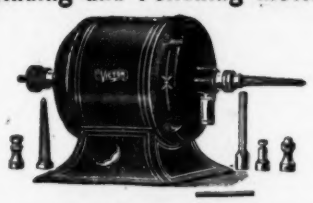

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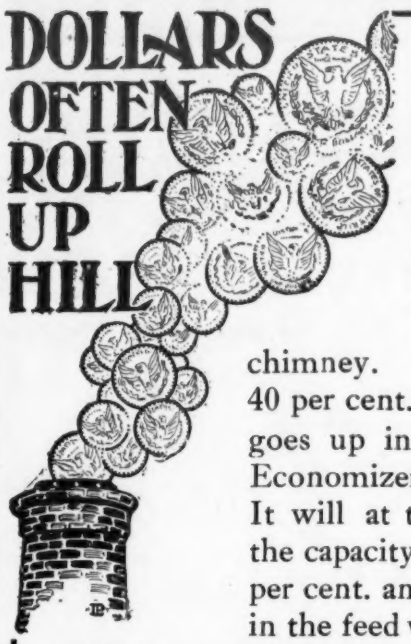

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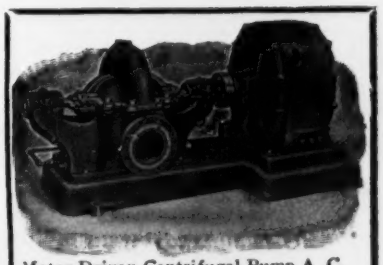

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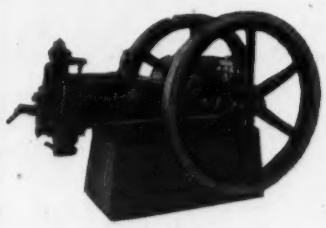

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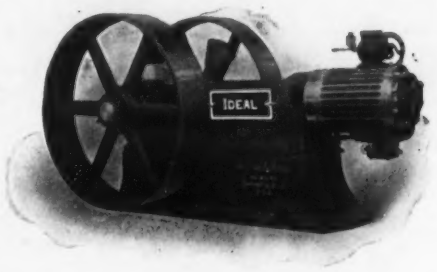

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No counter-balancing pistons or labyrinths. No projecting buckets. No guide buckets. No valves. No expensive oil compression system. No gears.

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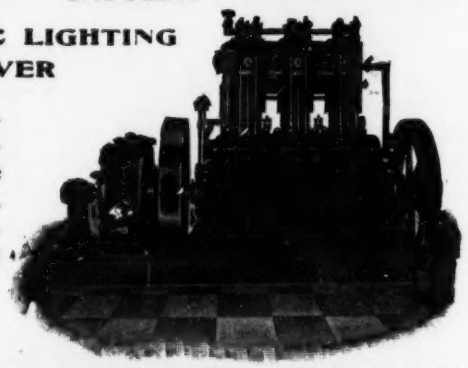

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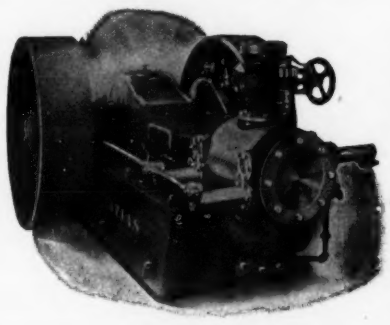

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for Electrical Service because it is the Most Economical, hence least fuel required. Perfect Lubrication, no overheating of parts. Simplest, smallest number of parts, ease of adjustment. Guaranteed Regulation. Efficiency in Electrical Service. Backed by the Atlas Guarantee—thirty years of successful Engine and Boiler building.

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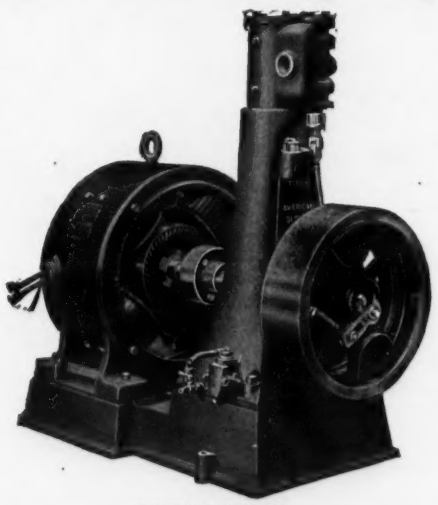

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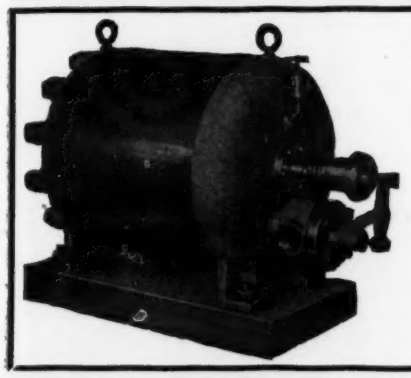

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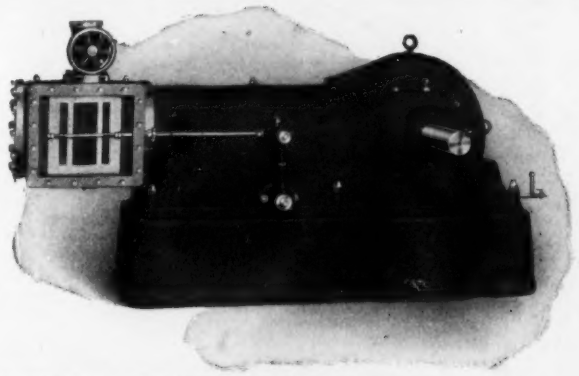

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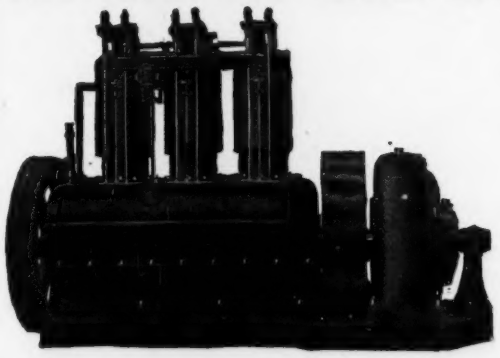

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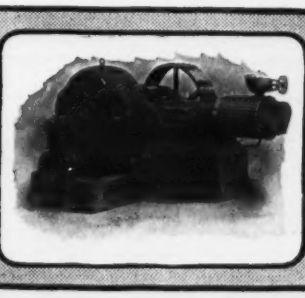

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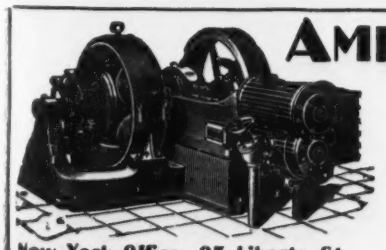

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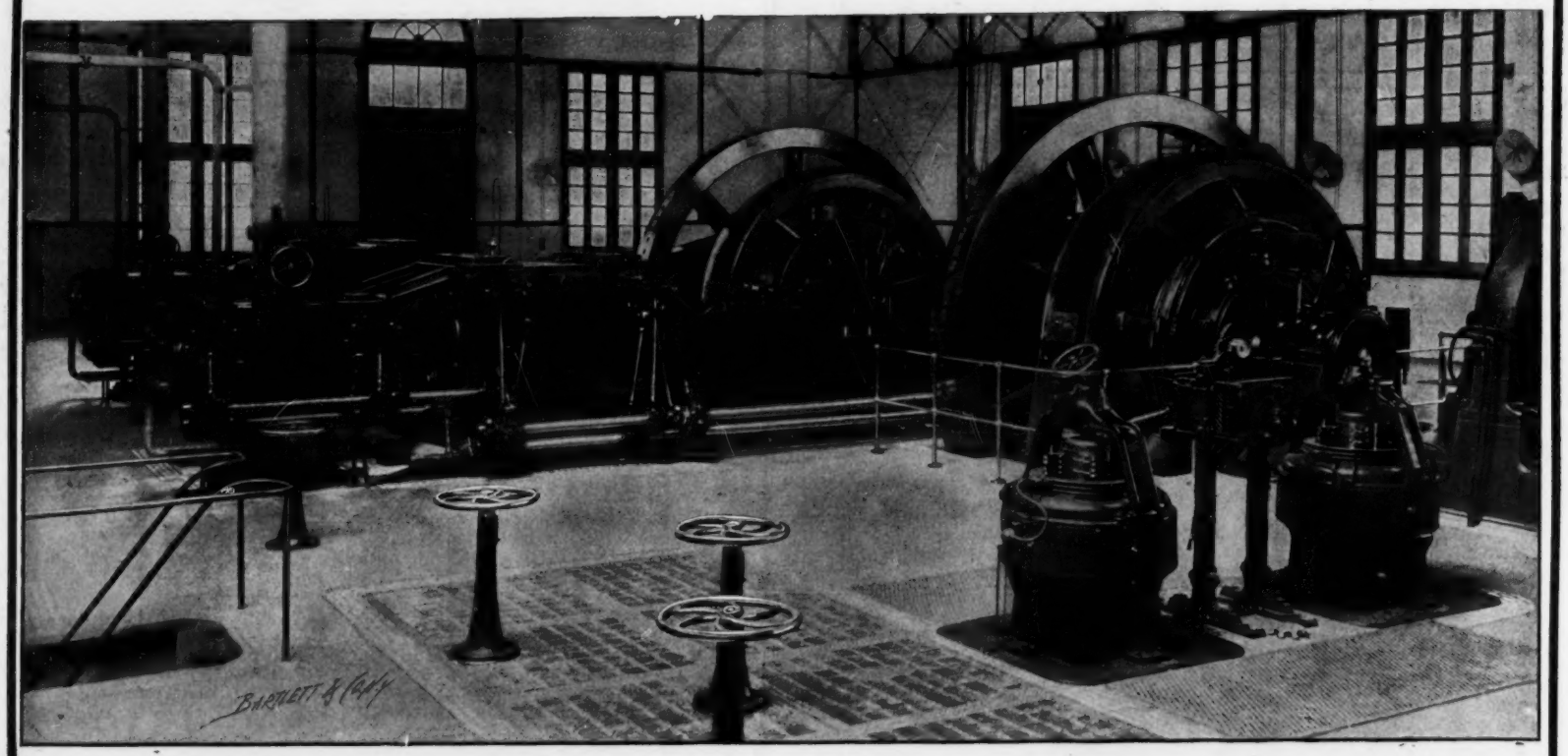

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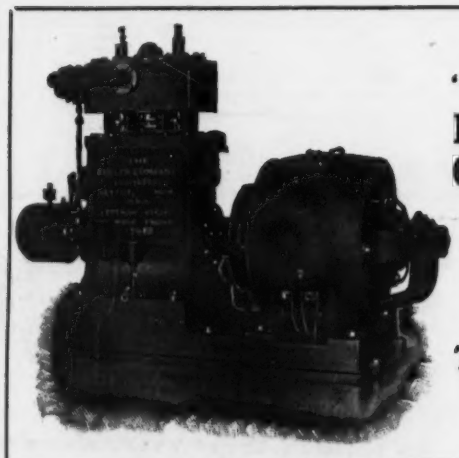

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A. A. Breder, Egg Harbor City, N. J., writes: "Please send, by mail, one blade for igniter lever, engine number 7185. This is my first order for repairs, and I have had my engine since October 3, 1900."

The part cost Mr. Breder 25 cents. Divide 5 years into 25 cents and find the annual cost of maintaining the engine. The *moral* is obvious.

OTTO OTTO OTTO OTTO

OTTO GAS ENGINE WORKS, Phila, Pa.

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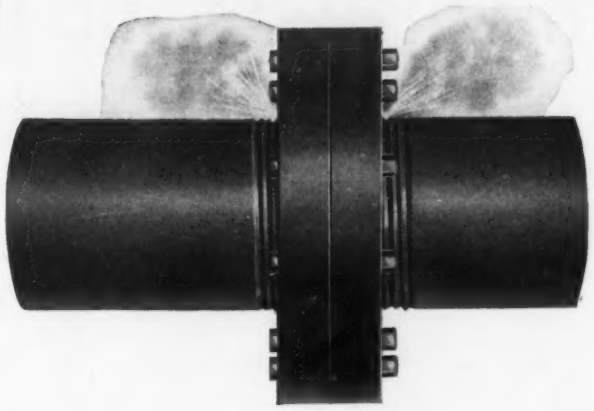


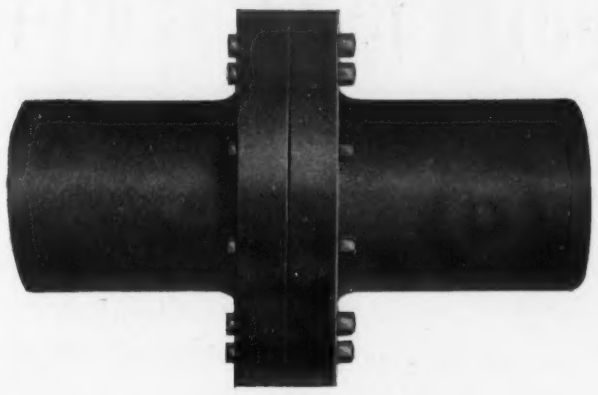
Here is a Leaky Flange Joint—

the meanest leak in the calendar to repair.

It is usually impossible to twist the pipe tighter in the flange for it is thoroughly peened in, and even if it were not, tightening this joint would loosen its next door neighbor.

If the leak is not fixed the steam cuts it larger. It means a shut down and two hours of heavy Steam Fitter's work.

There are two such joints to every flange coupling in the line.



Here is the Ballwood Welded Flange—

no joint at all.

Leaks are impossible and by it the weakest part of the steam line is made the strongest.

Count the flange joints on the drawings of your plant. Multiply them by two and you will have the number of chances for trouble that you will have if you use old-fashioned threaded flanges.

In almost every system of steam piping this figure will be at least 4 or 6 in many cases 40 or 50.

Is not the elimination of this number of sources of trouble worth something to you?

THE

Ball & Wood Company

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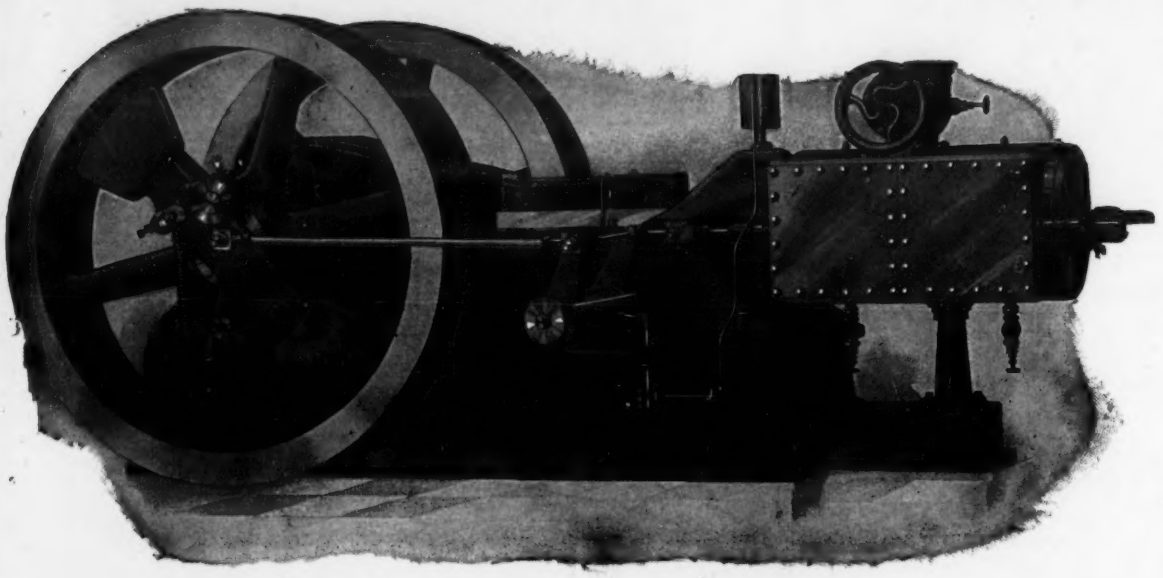
On a 28-day run, 12 hours a day, two 11x12 single-valve engines consumed 150 tons. On the same work, during a similar run, a 17x24 Watertown Four-valve Engine carried the same load with a coal consumption of 134 tons.



Net saving of the Watertown——

16 tons per month, 192 tons per year.

With coal at $2.90 per ton, the saving per year is

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Better investigate.

Write for details.

Watertown Engine Company, Watertown, N. Y.

3

SOUTHWARK FOUNDRY & MACHINE CO.

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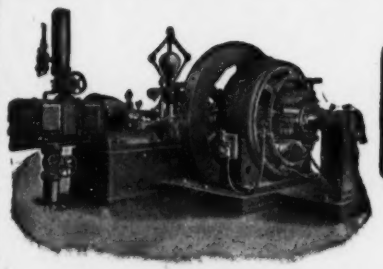

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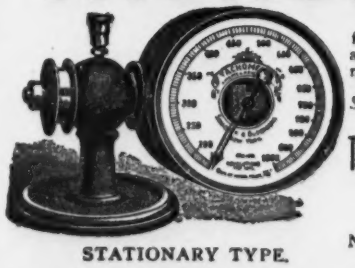

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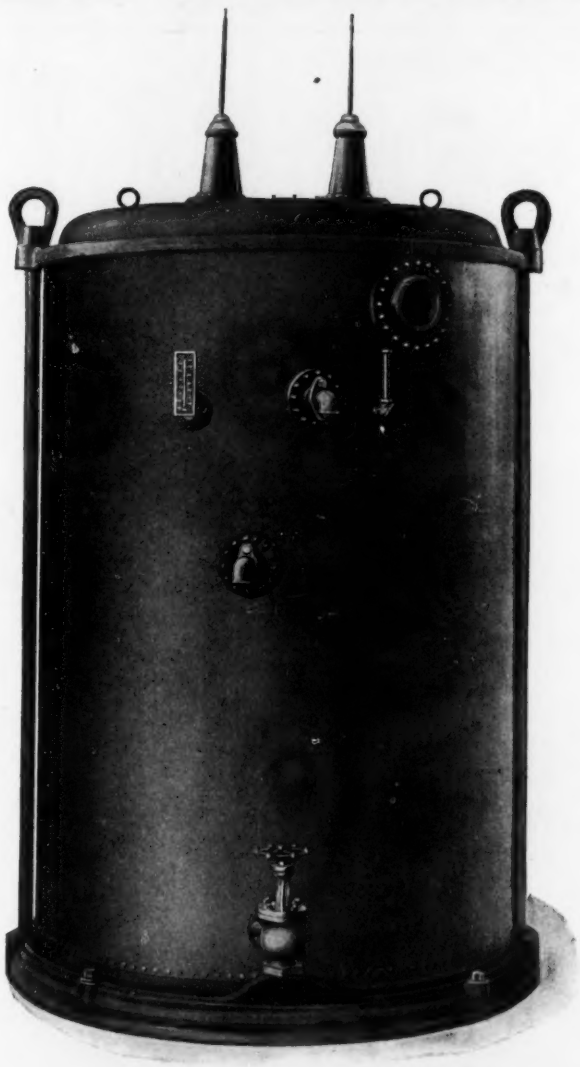

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25 Cycle, 500 K. W., 20,000 to 375 Volts

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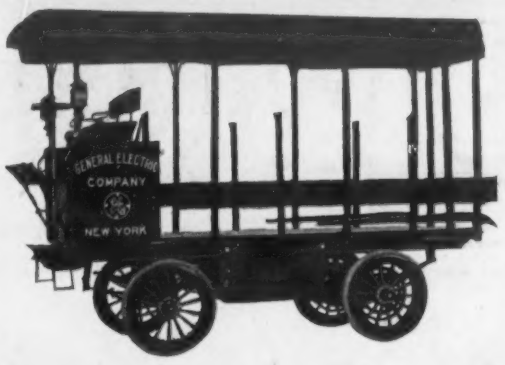

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(These points may easily be determined if you will take but a little time to investigate.)

3d.—That its efficiency when measured in *NET* HORSE-POWER, is the *very highest.*

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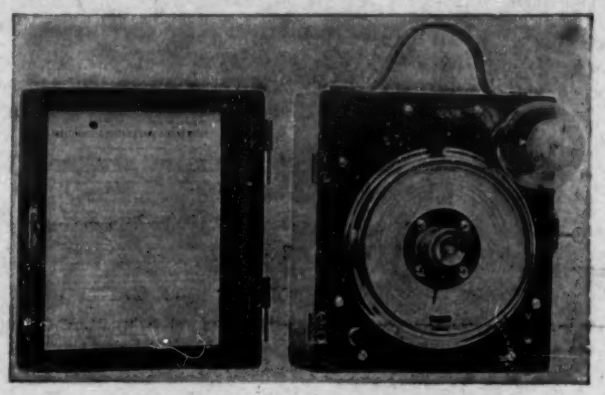

Two concentric scales are provided, one indicating watts and the other volts. By using the switch, cutting the series windings in or out, the wattage of the lamp or the voltage of the circuit can be read.

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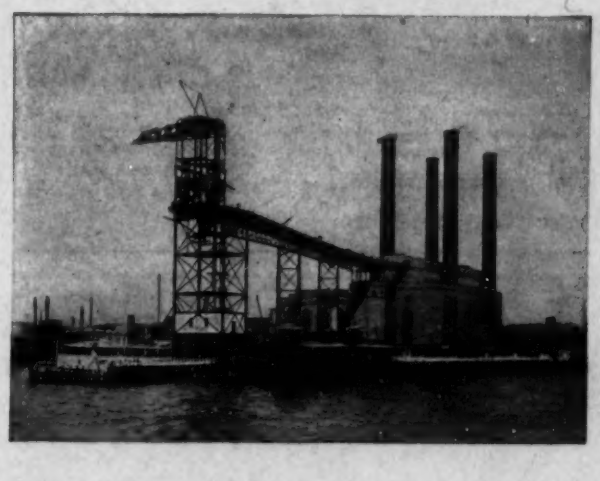
Furnishes high tension current for distribution to the five rotary converter sub-stations from which electric trains will derive their power. The present equipment consists of Three 5500 k.w.



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generating units. The plant is so constructed as to allow the duplication of this equipment when the Western Division of the Long Island R. R. is completely electrified.

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